DOCUMENTS EXPEDITING PROJECT

[COMMITTEE PRINT]

A STUDY OF SCIENTIFIC AND TECHNICAL MANPOWER

(A PROGRAM OF COLLECTION, TABULATION, AND ANALYSIS OF DATA)

OF THE

NATIONAL SCIENCE FOUNDATION

A REPORT

PREPARED PURSUANT TO A

COMMITTEE RESOLUTION

COMMITTEE ON SCIENCE AND ASTRONAUTICS
U.S. HOUSE OF REPRESENTATIVES
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CONTENTS

	Page
Foreword	v
Letter of Hon. Overton Brooks requesting study	vii
Resolution on the tabulation and study of scientific and technical manpower	vii
Highlights of the report	xi
I. The elements of a program of scientific manpower information	1
Meaning of the term "scientific manpower"	1
Content of a program of scientific manpower information	2
The users of scientific manpower information	3
Issues requiring scientific manpower information for solution	4
II. Techniques and methodology employed in the collection of scientific manpower information	7
Selection of respondents	7
Completeness of coverage	8
Collection methods	9
Voluntary and mandatory response methods	10
III. Agencies engaged in scientific manpower information program activities	13
Government agencies	13
Department of Commerce	13
Department of Defense	13
Department of Health, Education, and Welfare	14
Department of Justice	14
Department of Labor	14
Civil Service Commission	14
Selective Service System	14
Veterans' Administration	15
Atomic Energy Commission	15
National Science Foundation	15
Non-Government organizations	15
IV. The National Science Foundation program of scientific manpower information	17
Program responsibilities	17
National register of scientific and technical personnel	17
Historical development	18
The registration process	18
Current status of the national register	21
1960–61 register program	22
Scientific manpower studies program	24
General program operations	24
Specific program areas	25
V. A long-range program of scientific manpower information	29
General considerations	29
Considerations underlying the program	29
The principal program areas	30
The supply of scientific manpower	31
The demand for scientific manpower	33
Education and training information	33
Utilization of scientific manpower	34
Implications for the national register of scientific and technical personnel	35
The role of the National Science Foundation	36
Estimated cost of the proposed program	38
Recommendations for legislation	39
Appendixes	41
National Science Foundation letter requesting suggestions from interested Government agencies	41
Appendix A—Replies from Government agencies	42
Appendix B—Listing of National Science Foundation publications on scientific manpower	69

CONTENTS

FOREWORD

This report has been prepared at the request of the Committee on Science and Astronautics of the House of Representatives. That committee under date of August 6, 1959 requested the National Science Foundation to provide—

> * * * a comprehensive report covering (A) the status of the scientific and technical manpower register and the scientific manpower studies, and (B) the projected plans for the future, short range and long range, in these areas.

The committee resolution embodying this request was transmitted on August 26, 1959.

The National Science Foundation believes that the committee desires a broadly based reply. A program of scientific and technical manpower registers and studies involves many agencies, both Government and non-Government. These agencies are both producers of scientific manpower information and consumers of it. The Foundation has described its own programs in the framework of relationships with other agencies and organizations concerned with scientific manpower. A future program is proposed with emphasis on Foundation activities, but with the recognition that many organizations would share in it. The National Register of Scientific and Technical Personnel and the Foundation's scientific manpower studies program have very important responsibilities within this setting. However, there are alternative approaches which should be judged on their merits.

The National Science Foundation was instructed to consult with other interested Government agencies in the preparation of this report. The following agencies were specificially named:

Department of Commerce.
Department of Labor.
Department of Defense.
Department of Health, Education, and Welfare.
Civil Service Commission.
National Aeronautics and Space Administration.
Office of Civil and Defense Mobilization.
Selective Service System.
Central Intelligence Agency.
Federal Council for Science and Technology.

Discussions were held with these agencies, and they were asked to supply statements of their positions on the questions raised by the committee. The agency representatives were further given an opportunity to review the report in draft. While many valuable suggestions were received and taken into account, the final version of the report must necessarily be considered the responsibility of the National Science Foundation.

The study itself is composed of five chapters and an appendix. In the first three chapters are described briefly the content and uses of

scientific manpower information, the ways in which it is collected, and the principal collection programs. Chapter IV describes in more detail the present National Science Foundation programs, and chapter V presents a proposed program to be developed over the next few years. The appendix contains the agency views on the questions raised by the committee. A summary preceding chapter I covers the highlights of the study.

Grateful thanks are extended to the many agencies and their representatives who made the report possible by their constructive suggestions and comments.

ALAN T. WATERMAN, *Director.*

JANUARY 4, 1960.

LETTER OF REQUEST

COMMITTEE ON SCIENCE AND ASTRONAUTICS,
HOUSE OF REPRESENTATIVES,
Washington, D.C., August 26, 1959.

Hon. ALAN T. WATERMAN,
Director, National Science Foundation,
Washington, D.C.

DEAR DR. WATERMAN: As you may know, this committee considered a bill (H.R. 7981) on August 6, 1959, which would have provided for a special interdepartmental ad hoc committee to review the Nation's scientific manpower tabulation problems and report its findings back to the Congress for possible action.

At that time the committee voted to table the bill. However, it decided to substitute a committee resolution requesting that approximately the same study contemplated by the bill be made under the supervision of the National Science Foundation. The committee directed that a report accompany the resolution setting forth the committee's reasons for making the request.

I am, therefore, transmitting to you the resolution, as approved by the full committee on August 26, 1959, together with the report. It is our desire and hope that the Foundation will undertake the study requested in order to provide this committee with proper guidance in its efforts next year to improve the tabulation of the Nation's scientific and technical personnel.

I am forwarding copies of this resolution and the report to the heads of each of the Federal departments or agencies stipulated in the resolution.

Sincerely yours,

OVERTON BROOKS,
Member of Congress, Chairman.

RESOLUTION ON THE TABULATION AND STUDY OF SCIENTIFIC AND TECHNICAL MANPOWER

Approved August 26, 1959, by the Committee on Science and Astronautics, U.S. House of Representatives

Whereas the National Science Foundation Act of 1950 contains the following directive: "The Foundation is authorized and directed * * * to maintain a register of scientific and technical personnel and in other ways provide a central clearinghouse for information covering all scientific and technical personnel in the United States, including its territories and possessions"; and

Whereas the legislative history of the act shows that Congress attached high urgency to this matter; and

Whereas testimony before the committee indicates that Congress' directive has not been adequately implemented thus far and that this fact has been recognized by the National Science Foundation as well as other executive agencies and private organizations; and

Whereas testimony before the committee suggests that the register of scientific and technical personnel and its companion manpower studies have not been al-

lowed the priority granted to other programs of the National Science Foundation; and

Whereas nearly a decade has gone by since the National Science Foundation was created and charged with responsibility in this general area; and

Whereas the world situation today makes an effective tabulation of scientific and technical manpower more critical than at any time in the history of the country: Now, therefore, be it

Resolved, That the Committee on Science and Astronautics of the House of Representatives request the National Science Foundation to submit to the committee on or about January 4, 1960, a comprehensive report covering (A) the status of the scientific and technical manpower register and the scientific manpower studies, and (B) the projected plans for the future, short range and long range, in these areas.

That in the preparation of this report the National Science Foundation should consult with other interested agencies of Government, including the Department of Commerce, the Department of Labor, the Department of Defense, the Department of Health, Education, and Welfare, the Civil Service Commission, the National Aeronautics and Space Administration, the Office of Civil and Defense Mobilization, the Selective Service System, and the Central Intelligence Agency, and include in its report summaries of the specific interests, needs, and recommendations of such agencies.

That in the preparation of this report, the National Science Foundation should seek the advice and assistance of the Federal Council for Science and Technology and of such private organizations as may be deemed appropriate.

That the National Science Foundation, in submitting the report, should indicate—

(*a*) How the Foundation proposes to secure appropriate information on both the formal training of scientific and technical personnel and their subsequent experience;

(*b*) What type and kind of information an effective register could most advantageously supply and should be expected to provide;

(*c*) In what manner and through what means such a record may best be maintained;

(*d*) The pertinent findings and recommendations of the Foundation itself following evaluation of information production by this study.

That in making any recommendation to the committee, the National Science Foundation should include, among other things, the following:

(1) The probable cost of any recommended program, including the cost of maintenance and of adequate methods for keeping the program current.

(2) The estimated length of time which may be required to place an improved scientific and technical manpower tabulation program in operation.

(3) Whether the best results could be expected through compulsory or voluntary means.

(4) What agency of Government should bear responsibility for the program, and whether that responsibility should be exclusive or merely primary.

(5) What agencies of Government should be expected to cooperate with the agency responsible for the program and the manner in which such cooperation should be carried out.

(6) What amendments, if any, to laws now affecting scientific and technical manpower tabulations or registers should be made.

HIGHLIGHTS OF THE REPORT

1. Since 1953, the National Science Foundation has been discharging the responsibility assigned to it in the National Science Foundation Act of 1950.

> * * * to maintain a register of scientific and technical personnel and in other ways provide a central clearinghouse for information covering all scientific and technical personnel in the United States, including its territories and possessions;

In performing these functions, the Foundation has established and continually improved the National Register of Scientific and Technical Personnel. Similarly, it has been engaged in and supported numerous other activities for the purpose of determining the present and future position of the United States with respect to scientific and technical personnel. As conceived in the Foundation's program, studies of scientific manpower cover a broad range of such general topics as supply, demand, training, and utilization. As dealt with in this report, such studies are thought of as including natural scientists, engineers, technicians, and—in some cases—social scientists.

2. Approaches to the collection of scientific manpower information are varied. They range from data collected for a specialized purpose, such as the National Register of Scientific and Technical Personnel, to data collected as part of a more comprehensive collection program, as, for example, the decennial Census of Population. Each approach is likely to have its own unique advantages, and any program of manpower information, if it is to be effective, must utilize all of these approaches in an integrated fashion.

3. The National Register of Scientific and Technical Personnel is a departure from the several rosters of specialized personnel previously sponsored by the Government. The Foundation and professional scientific societies operate a joint program, with the Foundation establishing general standards and procedures and the societies carrying out the registration function. Registration data from all societies are processed and stored at a central records center. The Foundation has found register information especially useful for the study of professional and economic characteristics of scientists and for the location of specialists when needed for important Government purposes. Other sources of information are usually more appropriate in providing data on such other items as the demand for scientific personnel, number being trained, and the overall supply. Several data sources and methods are required for a comprehensive program.

4. Scientific manpower information collection programs in Government agencies are usually associated with broad functional assignments such as education, labor, the census, support of science activities, immigration and naturalization, etc. Government agencies most active in this field include the Departments of Health, Education, and Welfare, Labor, and Commerce; the Civil Service Commission; and the National Science Foundation. Non-Government organizations are also important contributors in the collection and analysis of scientific manpower information.

5. As the result of the Foundation's activities over the past 6 years, a great deal more is known about scientific and technical personnel than previously. Register data have been published or released in other ways to provide information on science manpower resources in specialized areas, levels of training, kinds of employers, functions performed, salary levels, foreign language knowledge, etc. Periodically, the Foundation has utilized other surveys to publish estimates of the total numbers of scientists and engineers, and the numbers engaged in research and development activities. Through Foundation encouragement and financial support, national education statistics have been improved to provide greater detail on fields of earned degrees, undergraduate majors in science, science faculty, and the baccalaureate schools at which science doctorates earned their first degrees. From time to time, comprehensive data are released covering a topic which is particularly timely; e.g., scientific manpower resources, education and training, or Soviet manpower in specialized fields. Finally, special studies and analyses have been made on such topics as the short-run demand for scientists and engineers, projections of supply, women in science, and others. An annual conference on scientific manpower has resulted in publication of numerous papers which have been highly useful to those engaged in the analysis of scientific manpower problems. (A list of publications issued or supported by the Foundation in the scientific manpower field is shown in app. B.)

6. Chapter V describes the program which should be developed in order to provide an appropriate level of scientific manpower information over the next 5 years. The general areas of supply, demand, training, and utilization are described in terms of specific studies which should be undertaken. Ways in which the more efficient dissemination of science information and the provision of more adequate scientific research facilities may result in the more economical utilization of scarce scientific talent should be further examined. The Foundation has been designated, by the Executive Office of the President, as the responsible agency in the executive branch for insuring that the information program on scientific manpower is implemented through support of appropriate data collection and analyses, the establishment of priorities, and the dissemination of results. However, several agencies should participate in the collection and analysis program.

7. The National Register is and will continue to be an important—though by no means the sole—source of information on the supply and characteristics of scientists in specialized fields. One of its major functions—the location of individual scientists under emergency conditions—is being further strengthened through extension of coverage and through closer coordination with mobilization agencies, who are the users of the register services. The register's principal past weakness has been the delay in collection, processing, and publication of the information developed from it. Too much time elapsed between the time the scientist was requested to supply registration materials and the time when analyses were available. While this weakness was principally the result of insufficient funds available to support the operation, delay on the part of many scientists in supplying information was part of the problem. Since the expansion of the data processing activities in 1959, the register tabulation program has been

greatly expedited. Future plans call for currency in address and characteristics information, and annual release of data collected.

8. Annual expenditures of $2 million for the national register and scientific manpower studies should be expected by not later than 1965. Operation of the program would be facilitated by additional statutory authority recommended for inclusion in the National Science Foundation Act. Such authority would encourage the use of both contracts and grants in carrying out the Foundation's functions in this area, and would allow more flexible coverage by including selected specialized personnel in addition to scientific and technical personnel.

9. Financial requirements, as indicated above, do not include any major register expansion, such as would be involved in a general coverage of engineers. It is proposed that decision as to the character of an engineers' register be postponed until after the recommendations resulting from the study currently underway are received from the engineering profession. At that time the Foundation will determine its program in this regard. If all engineers are to be registered on a basis equivalent to scientists in the national register, however, registrations will be multiplied perhaps five times. At this level, the register program would cover all the traditional engineering fields, including civil, mechanical, industrial, electrical, etc., and would itself probably require an annual expenditure between $2 and $2.5 million.

10. Specific questions posed by the committee are treated throughout the report at appropriate points. For convenience they are answered in summary below in the order in which the committee resolution raised them.

(*a*) The Foundation will continue to secure appropriate information on training and experience of scientific personnel through a variety of approaches. The National Register is one of the most important sources; however, other sources such as the decennial census of population, the earned-degree study of the Office of Education, studies of scientific manpower and research in industry, universities, and Government, and special studies of employment must be employed in the future as in the past. This approach yields more meaningful information, and is also likely to be less costly than would a complete census of all scientists and engineers. This survey approach is particularly valuable for studies in those areas in which samples can be effectively utilized.

(*b*) The register will continue to provide consolidated statistical information on the supply and characteristics of scientists and selected specialized personnel, and this function will remain the register's primary function in peacetime. However, under mobilization conditions, the register can readily and accurately identify and locate individuals with particular skills according to predetermined requirements. Efforts are continually being made to improve the register for both types of uses.

(*c*) The Foundation believes the present method of maintaining the register is generally a satisfactory one. The detailed study made in 1952 which led to establishing the register as a cooperative enterprise with the scientific societies has proven a wise decision on many counts. Joint operations by the Foundation and professional societies are of benefit in reducing the number of questionnaires scientists are asked to complete, permit Government to make effective use of the special-

ized knowledge of the professional groups, and make it possible to utilize existing organizational structures.

(*d*) Recommendations of the Foundation with respect to program, the roles of the register and the Foundation, and level of expenditures are contained in a final section (ch. V). Stated briefly, the Foundation recommends a program which utilizes existing agencies' facilities for survey work as much as possible. The Foundation will continue to program scientific manpower studies, determine priorities, and provide support where necessary. In addition to meeting the Foundation's own data needs, it is particularly important that the program provide for approaches to improving the techniques for the collection and analysis of manpower data, including research and studies of methodology. The register program is chiefly concerned with characteristics information for specialized personnel and location of individual specialists as needed.

(*e*) An annual expenditure level of $2 million, a 2-year recircularization cycle supplemented by annual address change information, and an annual data release program are essential parts of the program.

(*f*) Improvement in the tabulation program is a relative matter. It is constantly being improved. Marked improvements will be noted in 1960 as the result of greater resources made available in 1959. The outlined program will be reached in stages over the next 5 years.

(*g*) The Foundation believes, and nearly all of the other Government agencies consulted agree, that the register should operate on a voluntary basis during peacetime.

(*h*) The Foundation proposes to continue a program for which it has accepted the primary responsibility in accordance with an assignment by the Executive Office of the President. In carrying out this responsibility, the Foundation cooperates with and works through other Government agencies as appropriate.

(*i*) Government agencies which will continue to share in the continuing and enlarged program include both the major producers as noted above (see also ch. III) and users of scientific manpower information. Coordination and cooperation will be assured through the establishment of a group consisting of representatives from the various interested Government agencies to work with the Foundation in an advisory capacity. This group will assist the Foundation to develop a Government-wide attack upon data-gathering problems, in establishing project priorities, and in providing (through the various agencies represented) other support as needed to achieve program goals.

(*j*) The Foundation believes it would be helpful if the National Science Foundation Act of 1950 were amended to authorize specifically financial support arrangements for the register and clearinghouse functions similar to that specifically authorized for other Foundation activities. Furthermore, more flexibility is desirable for the coverage provisions in this activity.

A STUDY OF SCIENTIFIC AND TECHNICAL MANPOWER

I. THE ELEMENTS OF A PROGRAM OF SCIENTIFIC MANPOWER INFORMATION

In order to delineate as clearly as possible the frame of reference of this report, a definition of the term "scientific manpower" is in order. It is an often misunderstood phrase; furthermore, a definition will serve to assist the presentation that follows. This chapter will also enumerate some of the types of data included under scientific manpower information, and the users of such materials. Finally, some of the issues requiring scientific manpower information for their solution will be suggested.

Meaning of the term "scientific manpower"

Scientific manpower broadly comprises that portion of the labor force trained in the application of scientific and engineering principles and employed in positions requiring such applications. While individuals comprising this category of workers usually receive their training through formal educational programs at colleges and universities, some persons are trained through other methods, including self-instruction and on-the-job training. While it is most frequently considered to include the professional occupations, the term is sometimes broadened to include the technicians who assist the scientists and engineers and whose training may be oriented more toward the practical applications of scientific principles rather than the theoretical aspects of these principles. The scientific manpower category is frequently considered to include those trained and employed in the social sciences as well as those in the natural sciences and engineering.

An example of one of the inadequately defined concepts in this field is the term "engineer." Under some definitions, only personnel formally trained to the baccalaureate level in engineering are counted as engineers, and these persons may be so included irrespective of whether present employment involves the use of such training. At another extreme, personnel employed at what may be considered "engineering" jobs are included as engineers regardless of their formal training.

For present purposes, it is proposed to use the term "scientific manpower" to include those trained in the natural and engineering sciences and employed in occupations requiring the use of such training. Specifically, the term will be considered to include the professional engineers, mathematicians, physicists, chemists, life scientists, earth scientists, and those in certain areas convergent with social sciences, such as psychologists, geographers, anthropologists, etc. While it is more debatable, it seems desirable for this purpose to include generally supporting technicians in these fields. These

occupations are closely related to their professional counterparts, and become particularly important in demand-supply studies. Where social scientists are included, this will be made clear from the context.

Content of a program of scientific manpower information

The content of a scientific manpower information program is necessarily broad. This stems from a number of causes. The central importance of such manpower to the economy and its location in all economic segments call for information not only on numbers and characteristics but also on certain institutional relationships. The lengthy training process calls for data at various stages of the educational ladder. The relatively high standards demanded for success in this field have implications for information on the basic ability levels of the population. Recent shortage situations emphasize the desirability of information on present and prospective supply.

Numerous as these several types of information sought are, they are simply recognition of a central belief. This may be expressed as the general acceptance of the position that scientific and technical manpower holds a key role in the continuing growth of our economy, the maintenance of an adequate national defense posture, and the preservation of our position of international leadership. It implies further that well-qualified scientific personnel are in short supply, and that special steps should be undertaken to assure the development of adequate numbers for future years.

Specific content of a program may be conveniently grouped into such commonly treated categories as supply, demand or requirements, training, and utilization. It is recognized that these topics are not mutually exclusive, and categorization of a specific piece of information may be more a matter of personal preference than of a generally accepted logical arrangement.

The term "supply data" is used to encompass the broad area of information on current and projected resources of scientific manpower. It includes data on professional and personal characteristics of the supply, including such factors as scientific specializations, levels and character of training, functions performed, location, age, sex, income levels, employment status, type of employer, etc. Scientific manpower is part of the broad group of professional, technical, and kindred workers' occupations. As such, it is often desirable to make comparisons with others in this group, such as the medical practitioners, attorneys, social scientists, humanists, teachers, and other professional categories. On another dimension, supply data involve potentials as well as actual situations. Those involved in occupational transfers, return to employment from a retired status, refresher training programs, and migration may properly be part of any data program on the resources of scientific and technical personnel as a potential of supply.

Information on the demand for scientific personnel includes estimates of current and future requirements in terms of scientific specializations, functions to be performed, levels of training required, types of employers, etc. It is concerned with present patterns of use of scientific manpower and likely future patterns. Nonmanpower factors, such as national income and product, volume of business activity, production, and the level of research and development activity, provide some relationships which may indicate levels of demand. Em-

ployer hiring expectations, salary movements, and "help wanted" advertisements are other types of information included on the demand side.

Training information includes broadly the numbers being trained for scientific work at various stages in the training process, the character and quality of training being given, the facilities and resources for training, etc. It is concerned with costs and financing of training. Training completions and student losses during the process are parts of the picture. The roles of special technical schools and industry in the training process also need to be studied.

A final major area of information is that of the utilization of scientific personnel. Included here are such matters as patterns of utilization in terms of tasks requiring scientific training, methods of economizing in the use of scientific personnel, and the like. The extent to which technicians and nonscientific personnel are used to aid the professional scientist, the availability and use of laboratory equipment and teaching aids, provision for inservice training, and job dilution are all topics important to the understanding of scientific manpower utilization.

Underlying all these areas of scientific manpower data is the important one of information on public and individual attitudes toward things scientific. This does not lend itself to discussion as a separate area, but might be considered in conjunction with each of those enumerated. For example, the public attitude toward science is important in determining the numbers of potential scientists who may be trained and later become practicing scientists. Similarly, an attitude that basic research is a desirable activity for an industrial establishment will influence the demand for personnel. This factor of attitude is an important aspect of scientific manpower information, difficult as it is to reduce to any quantitative evaluation.

The users of scientific manpower information

A scientific manpower information program should be designed to provide timely and reliable information to a broad band of users. They will include a range from those concerned with policy development and substantive program operation through the individual scientist concerned with his own vocational development, to the individual citizen concerned with progress toward national goals generally accepted as proper for the Nation.

In the first place, there is the concern of Government with science manpower as an essential national defense resource. Development and maintenance of a strong scientific manpower position are important in ways similar to the maintenance of a strong industrial or financial base. Scientific manpower information then becomes a tool for the evaluation of the Nation's current position and an indicator of necessary remedial measures.

Government agencies have moreover become the largest supporters of research and development programs, and both Federal and State agencies make large contributions to the cost of training scientists and engineers. In its capacity as an employer, the Federal Government has more scientists and engineers on its rolls than any other single employer. The Congress, in its role of making available the funds used by the Federal Government for these many purposes, is concerned with program direction and effectiveness. Effective use of

scientific manpower information here should assist in planning the scope of programs having science manpower implications, in measuring the progress being made by such programs whether it be in terms of the changing functions of scientists or of additions to the supply, and in evaluating the effectiveness of programs in relation to the predetermined goals.

Educational institutions, as the principal producers of the science manpower product, represent another important class of users. Information on specializations currently and prospectively needed could do much to help adjust the training potentials to the requirements realities. As large employers of such personnel, colleges and universities are concerned with the competition from other employers of scientists and engineers and are interested in information on employment conditions.

The concern of private industrial establishments as users of scientific manpower information is likely to be in terms of the market for the services of scientific personnel and their patterns of utilization. Competitive salaries and working conditions, the assessment of the supply in training, available supply in terms of locations and specializations are likely to be the common uses of such information on the part of industry.

The scientific community in general, and the professional scientific societies in particular, are concerned with scientific manpower information as an indicator of trends within their several disciplines. Salary levels and shortage situations reflect existing relationships of demand and supply. Information on quality and gaps in training signals a need for the development of programs for professional growth. Trends and direction of growth in science may be measured in scientific manpower terms. The fostering of scientific advances and encouraging the professional growth of scientific and technical personnel are greatly dependent upon the availability of timely information for the science community.

Finally, the public is a user of such information to judge the extent to which national objectives are met. While public opinion does not establish national science goals, it creates the climate within which such goals can be set. Whether these be in terms of expenditures for scientific research, of numbers of scientists trained, or in terms of maintaining international leadership, information on science manpower is always a pertinent—and frequently the only—method of evaluating progress toward the accepted goals. The public press reflects public opinion in calling for information on such topics.

Issues requiring scientific manpower information for solution

In 1958 a special Advisory Panel to the National Science Foundation and the President's Committee on Scientists and Engineers (frequently referred to as the Hauser Committee) reviewed the Government's scientific manpower information activities and recommended the collection of considerable additional data. As a part of its review, the Panel noted the important current issues for which scientific manpower information guidance seems imperative.

According to its report, these issues can be summarized as—

> The extent to which scientific and technical talent and skills should be encouraged and developed to increase the supply of scientists, engineers, technicians, and teachers of science;

The ways in which the teaching and study of science should be furthered and the means of doing so;

Methods of raising the standards of teaching and training to improve the quality of scientists, engineers, and technicians;

Development of the criteria for military induction, occupational and student deferment, and Reserve screening;

Determination of the optimum level of Government-financed research;

Determination of the levels of compensation of scientific and technical personnel, both civilian and military, and of means of improving their prestige and morale;

Methods of conserving and utilizing to the greatest possible extent the available scientific and technical manpower.[1]

The Panel went on to note that these issues are of concern to both Government and private organizations. Where there exists, as in this country, no central authoritative control over the flow of talent into specific occupations, it is particularly important that there be available "timely, precise, and comprehensive data as a basis for the development of * * * manpower policies."

[1] "A Program for National Information on Scientific and Technical Personnel," National Science Foundation and President's Committee on Scientists and Engineers; NSF 58-28; p. 15.

II. TECHNIQUES AND METHODOLOGY EMPLOYED IN THE COLLECTION OF SCIENTIFIC MANPOWER INFORMATION

Numerous varying methods are used in the collection of scientific manpower information. Each of them may have certain unique advantages in given situations, and the appropriate method in a given case is dependent upon such factors as timing, precision required, relative expense, and the like. In this section each of the major methods for obtaining scientific manpower data will be discussed.

Selection of respondents

The appropriate respondent from whom information is sought in a given case must, of course, either be in possession of the information or be in a position to secure it. Furthermore, he must be willing to supply it. Generally speaking, where there is a choice of more than one class of appropriate respondents, it will be more economical to collect information at those points which are existing repositories of information collected from individual respondents.

Types of respondents from whom scientific manpower information is commonly collected include individuals (usually scientific personnel), employers and employing establishments, households, professional societies, and institutions engaged in the training, development, and guidance of scientific manpower.

Collection of data directly from individuals is especially appropriate where detailed information regarding professional or personal characteristics is sought. Such information as schools attended and degrees held, place of birth, age, employment and professional history, income, language and area knowledge, and attitudes are kinds of data best known to the individual himself, if known at all to others. Another level of information available from individuals but from other sources as well includes employment specializations, functions performed, salary levels, industry of employment, etc.

In given situations, the advantages of collection from individuals must be weighed in the light of existing disadvantages. For example, a relatively higher cost involved in collecting information from a large number of individual respondents may be decisive in the decision to collect certain types of data from the employers of scientists, even though it may be less perfectly known. In such a case the difference in the number of respondents would be a significant factor.

The principal data collection program from individual scientific personnel is the National Register of Scientific and Technical Personnel, operating under the joint sponsorship of the National Science Foundation and a number of our national professional societies. This program produces relatively detailed information on the name, address, scientific and professional specializations, education and training, type of employer, functions performed, salary and income level, language and area knowledge, etc., of each scientist registered. The Selective Service System similarly collects some employment and education information directly from individuals in connection with

the administration of the Selective Service Act. A combination individual respondent-household approach is found in plans for the 1960 census. Through the use of a self-enumeration form, the Bureau of the Census expects that most scientific personnel will supply required information personally. Where the form is not so completed, other household sources will be sought.

Employers and employing establishments are usually appropriate respondents for data collections dealing with employment. Where information is sought on employment and working conditions, salaries (in contrast to income), functions, type of industry, requirements, recruitment practices, etc., the employer is likely to be the most appropriate respondent. He also represents, in effect, a repository where certain information has already been collected for his own personnel and payroll purposes. To the extent that the information being sought is already a matter of record, the problem of collection may be greatly simplified. The scientific manpower information programs now utilizing the employer collection approach include the survey of scientific personnel in industry by the Bureau of Labor Statistics; analysis of local labor market conditions by the Bureau of Employment Security; the study of research and development scientists in Government by the Civil Service Commission; and the survey of employer hiring intentions by the Engineering Manpower Commission.

The household is not generally used as the appropriate respondent for scientific manpower surveys. The household approach is best adapted to collection of those types of information which will generally be known to the members of one's immediate household; such as employer, type of work, occupation, level of education, age, etc. Specialized information relating to highly detailed professional and employment characteristics may be less satisfactorily reported. Combination of the individual respondent-household approaches, noted above, has definite advantages in this regard.

Professional scientific societies are important sources of information on their membership, and, to a lesser extent, on their professions generally. Through their contacts with members, the societies are familiar with current and emergent scientific specializations, general salary levels, current demand-supply relationships, and working conditions within the professions. Reports and special studies published by the societies from time to time supply useful information on current developments.

Finally, there are a number of other institutions which supply information on scientific manpower. Notable among them are the educational institutions which provide data on the training process, the numbers in training, and the numbers completing training at the several levels. Foundations and academies of science are frequently both respondents and collectors of information on trends and current problems. Typical of reports collected from these types of sources are the annual studies of college and university enrollment and degrees granted, carried out by the U.S. Office of Education.

Completeness of coverage

Scientific manpower information may be collected from an entire class of individuals or establishments or from a smaller group carefully designed to represent with a high degree of accuracy the same char-

acterisitics as that of the entire group or "universe" for which information is sought. This technique of measurement through "sampling" has been developed to a point where the results of well-designed studies carried out in this way can be relied upon with great confidence. Cost and timing as well as the amount of detailed information desired are important considerations in the decision of which approach to follow.

Complete-coverage surveys are generally more costly to administer since they involve a larger number of respondents. Those costs associated with mailings, interviews, schedule editing and processing are rather directly related to the volume of respondents. A particularly difficult—and costly—element of such studies is the problem of "following up" on nonrespondents; it may prove to be as expensive to get data on the last 5 or 10 percent of the intended respondents as it is to get the data on all the rest. More time is likely to be involved in a complete enumeration. However, where for some overriding reason data on all individual respondents are desired, complete coverage is necessary. Furthermore, where detailed cross tabulations or identification of infrequent characteristics with a high degree of precision are important, complete coverage will be more desirable than partial coverage.

Typical of complete coverage surveys are the earned-degree studies of the U.S. Office of Education. This survey attempts to secure a report on the number of degrees awarded, including those in science and engineering, from each degree-granting institution of higher education. The 1960 Census of Population will be a combination of a complete enumeration of the population combined with a sample enumeration of occupations.

Partial-coverage surveys range from the carefully selected scientific sample, where results can be related to complete enumeration within known limits, to the results of "complete enumeration" surveys which have failed to elicit a "complete" response. As noted above, partial coverage surveys, particularly those designed with a carefully selected sample base, may be the most appropriate method where information on all individual cases is not essential.

Partial-coverage surveys with a high proportion of the universe covered can be valuable, particularly if the general character of bias is known. Where data for more than half of a universe are known, relatively simple tests can frequently be applied to assess validity. On the other hand, partial-coverage studies with low representation of the universe and no systematic coverage basis can be extremely misleading and subject to unknown bias.

An example of the scientifically selected sample survey is the study of scientists and engineers employed in industry administered by the Bureau of Labor Statistics. This survey is based on a sample of about 12,000 companies selected to represent some 160,000 industrial employers. Partial coverage surveys with a high proportion of the universe covered include the National Register of Scientific and Technical Personnel and the salary surveys of research scientists sponsored by the Los Alamos Scientific Laboratory.

Collection methods

Numerous methods may be employed in the collection of scientific manpower information. Personal interviews, mail questionnaires,

telephone calls, telegraph, etc., may each have advantages under special conditions.

By far the most generally used method of information collection is the mail questionnaire. It is relatively inexpensive as compared with other methods, it can reach to all parts of the country, and can be efficiently handled on a mass basis. It goes without saying that care in preparation of the schedule and instructions is important in eliciting prompt and accurate response.

The use of personal contact, such as personal or telephone interview, is usually restricted to situations where the number of respondents is small. The advantages of this method stem from the personal relationship, the opportunity to explain purpose and instructions, and the ability to interpret the results better. In general, its relatively high cost makes it inappropriate for large-scale data collections.

Frequently, a given study will quite properly involve several different data collecting methods. A pretest of a proposed schedule may be conducted through personal interview of a limited number of respondents. The mass collection program which follows may then become a mail survey. Finally, nonresponse may be greatly reduced through the judicious use of telephone or telegram followup techniques.

Scientific manpower information may be collected on a single-time or on a repetitive basis. The single-time inquiry fits well into relatively static situations where sweeping change is not expected. Considerations of expense and burden upon respondents are important in determination of collection frequency. For the more important and dynamic facts of science manpower, periodic and repetitive reporting has become increasingly necessary. For example, such rapidly changing matters as employment levels in the principal employing sectors and the degrees granted in science fields should be measured on an annual basis. A common pattern has been a single-time study, which becomes a periodic one as the subject studied becomes a more critical one from the standpoint of national interest.

Voluntary and mandatory response methods

Traditionally, scientific manpower information has been collected almost entirely through the voluntary cooperation of respondents. The history of rosters and registers of scientific personnel, even during World War II, has always been one of relying upon voluntary response. The point was made in the congressional debate during the period of consideration of the National Science Foundation Act and the National Register of Scientific and Technical Personnel that no scientist should be registered without his consent.

There have been, however, a few notable exceptions to the principle of voluntary response. The census of population is a mandatory enumeration, and respondents failing to supply census data, including that on occupations, are subject to statutory penalties. In connection with the administration of the Selective Service Act, registrants are required to supply information on occupation, type of employment, and training. The requirement that certain professional workers, notable physicians and engineers, must register in some jurisdictions in order to practice licensed occupations is more a matter of protection of the public than identification of individuals with selected training.

Any general requirement that scientific personnel must register and provide professional and personal information to the Government

in peacetime would be repugnant to many. Even with the safeguards of a democratic country, such a registration has unfortunate connotations both to the scientist and his employer. A compulsory system requires sanctions which can be imposed if necessary. There is a difficult—perhaps impossible—problem of accurately defining the characteristics of the individuals who should come within the provisions of such a registration. Given the repugnance attached to compulsory registration, the establishment of penalties for noncompliance might serve to weaken the entire structure of cooperation between Government and the scientific community. In view of the ever-increasing importance of encouraging qualified young people to enter careers in science and engineering, many feel that a compulsory registration system for those in these occupations would be a malmotivating influence.

A mandatory collection system is not necessary under normal conditions. A sufficiently high response rate can be obtained through voluntary methods, if all respondents, individual, industrial and institutional, are adequately assured of the needs to be met by the information requested. A 100 percent rate of response will not be achieved by such methods, but such a high rate would not warrant the extreme conditions which would be imposed in attaining it in view of the normal kinds of uses served. A rate of response sufficiently high—perhaps 80 to 90 percent—can be achieved. Under the unusual circumstances of national emergency or mobilization, a compulsory registration system with its ability to locate practically all qualified individuals might very well be desirable.

III. AGENCIES ENGAGED IN SCIENTIFIC MANPOWER INFORMATION PROGRAM ACTIVITIES

Among the characteristics of scientific manpower information in this country are its diversity and the number of organizations involved in producing it. No one agency can be looked to as the sole producer of such information; rather, it is a responsibility of many organizations. Nor is this a phenomenon peculiar to this type of information. The U.S. statistical system is a decentralized one with statistical studies and surveys most likely to be associated with agencies having substantive program responsibilities in a given field. Scientific manpower follows the same general pattern, with data emanating from those agencies concerned with the training, employment, research and development, immigration, recruitment, placement, etc., of scientists and engineers. While the Government agencies are the principal producers of such information, some private organizations are commonly relied upon to produce certain data or to undertake research studies in this area.

This chapter will briefly review the principal kinds of information produced by the Government agencies active in this work. In addition, a sampling of non-Government organizations will be presented, indicative of the kinds of data produced by them.

Government agencies

Many Government agencies are engaged in one or more aspects of the collection of information on the supply, demand, utilization, and training of scientific and technical personnel. In spite of the number of agencies involved, there is little duplication or overlap. All of these efforts result in valuable contributions to the total supply of scientific manpower information. Most of the information is collected by a relatively small number of Government agencies.

Department of Commerce.—The Bureau of the Census collects and publishes scientific manpower information in connection with the decennial census of the population. As part of the 1960 census, information on scientific, professional, technical, and related occupations will be obtained on a 25-percent sample basis. In addition, demographic information is reported as part of the "Current Population Survey." Another study of importance in this connection is the annual survey of industrial research and development expenditures. This study typifies a type of study carried out by another governmental group on behalf of the National Science Foundation.

The Bureau of Public Roads occasionally collects statistical information on numbers and training of engineers engaged in highway work in State and local governments.

Department of Defense.—The Department of Defense obtains manpower information on its own personnel. Data are published occasionally on scientific and engineering personnel engaged in research and development activities in the Department of Defense. This specialized information is generally available in the different service

50730—60——4

segments within the Department. Manpower information within the Department of Defense is coordinated by the Assistant Secretary (Manpower, Personnel, and Reserve).

Department of Health, Education, and Welfare.—The Office of Education publishes information related to educational institutions and persons engaged in the teaching profession. Data are published annually on the number of degrees granted, college enrollments, enrollments in engineering and science, and number of teachers. Less frequent data are provided on secondary school science and mathematics enrollments, financial support of students, etc. A new survey will provide information on advanced degree enrollments by discipline. The Office of Education operated the National Scientific Register prior to the transfer of this activity in 1953 to the National Science Foundation.

The Public Health Service cooperates with the Foundation in maintaining the sanitary engineers segment of the National Register of Scientific and Technical Personnel and undertakes studies in this field. The National Institutes of Health are a source of information on the training, deployment, and utilization of medical and biological scientists.

Department of Justice.—The Immigration and Naturalization Service collects occupational information on immigrants. It is possible to secure data on numbers of scientist and engineer immigrants from this source.

Department of Labor.—The Bureau of Employment Security is a source of information on the number of openings for scientific personnel at the public employment offices. Periodic analyses of local demand-supply relationships for such personnel are made. Occupational studies provide some information on industrial employment patterns. The Bureau also conducts job analysis and definition studies on scientific as well as other occupations.

The Bureau of Labor Statistics maintains monthly statistics on overall employment, analyzes certain manpower supply and demand problems, and carries out occupational outlook studies. The Foundation has supported the Bureau of Labor Statistics in surveys measuring the employment of scientific and technical personnel in industry, nonprofit organizations, State governments, and local governments. In addition, special surveys of scientific personnel are made from time to time. A current program of some promise in the Bureau is the Foundation-supported experimental study of science manpower requirements in industry.

Civil Service Commission.—The Civil Service Commission maintains information on Federal Government employment, payroll data, and other personnel statistics. It conducts an annual survey of all Government employees in white-collar occupations, including professional workers in science and engineering. The Commission also maintains a special Federal Roster of Scientists and Engineers at the GS–13 and higher classification levels in selected job series; this roster is closely coordinated with the NSF-supported National Register.

Selective Service System.—Occupational information is maintained on the registration, classification, and deferment of those persons liable for military service under the Universal Military Training and Service Act. Statistics are maintained by the Selective Service

System on the number of scientists and engineers as they relate to deferments.

Veterans' Administration.—The Veterans' Administration provides some information on certain training programs which are provided for veterans and administered by it.

Atomic Energy Commission.—This agency carries out surveys (and sponsors others) of certain specialized scientific and engineering manpower in industry and educational institutions. This information has resulted in estimates of the number of persons engaged in the "atomic energy" industry.

National Science Foundation.—The Foundation has the dual responsibility of providing information on the training and research programs supported by it, and providing further for data on scientific and technical personnel generally. Training programs produce information on fellowships granted in science and engineering, teachers and students attending the various training institutes programs, character and scope of special training projects, and progress of curriculum revision studies. Similar data can be secured from operations of the research programs in terms of extent of support, fields of science, and estimated manpower engaged. Other data with implications for scientific manpower may be derived from the science information and facilities programs. (Within NSF, studies of the national volume of research and development and its impact upon the economy are the responsibility of the Foundation's Office of Special Studies.)

The unit of the Foundation charged with responsibility for carrying out its scientific manpower information program is the Scientific Manpower Section. The three major segments of this activity are: The National Register of Scientific and Technical Personnel, Scientific Manpower Studies, and Manpower Research. Details of these programs will be described more completely in chapter IV.

Non-Government organizations

As pointed out above, the accumulation of scientific manpower information is not the exclusive province of Government agencies. Many private organizations are major producers of such information and play a responsible part in the national picture. Research institutes, universities, and professional societies have been among the more important producers, and the contributions of trade associations and private companies have been considerable.

The most frequent pattern has been that the non-Government agencies engage in analytical and research activities, leaving to Government agencies the underlying mass data collection programs necessary to support such analysis. Although there have been exceptions to this general principle, as a rule the resources of non-Government agencies are insufficient to undertake large-scale surveys.

The private organizations mentioned below by no means represent an exhaustive list of those engaged in scientific manpower activities. They represent rather a sampling of agencies and typical activities carried on.

The National Bureau of Economic Research in New York City is an independent research institution whose objective is to ascertain and present to the public important economic facts and their interpretation in a scientific and impartial manner. The National Science

Foundation has supported this organization in the past in the conduct of a research study on the demand and supply of scientific personnel.

The Bureau of Applied Social Research at Columbia University has conducted research in the field of scientific manpower. The Foundation has given financial support to studies conducted by this organization to determine the future supply of scientific personnel.

The National Academy of Sciences-National Research Council has a continuing program of scientific manpower studies in its Office of Scientific Personnel. The National Science Foundation currently supports this agency in a research program on the techniques of selecting science fellowship awardees. In addition, the National Research Council under contract with the Foundation collects and maintains a record of all doctor of philosophy degrees currently awarded in the United States as part of the National Register program.

The National Manpower Council was established at Columbia University under a grant from the Ford Foundation to study significant manpower problems and to contribute to the improved development and utilization of the Nation's human resources. This group has issued a number of reports bearing on scientific and technical manpower, among which are: "A Policy for Scientific and Professional Manpower"; "A Policy for Skilled Manpower;" and "Womanpower."

The National Education Association conducts an extensive research and survey program on American education and teachers. Of particular importance to scientific manpower are its studies of the demand and supply of teachers for universities and secondary schools.

The Engineering Manpower Commission and the Scientific Manpower Commission are parallel (and closely coordinated) organizations of professional societies in engineering and science. Each of them is active in the development and interpretation of national science manpower policies. The Engineering Commission particularly engages in surveys of industry hiring intentions and salary levels for engineers.

Nine major professional scientific societies—American Chemical Society, American Geological Institute, American Institute of Biological Sciences, American Institute of Physics, American Mathematical Society, American Meteorological Society, American Psychological Association, Engineers Joint Council, and Federation of American Societies for Experimental Biology—and through them some 200 additional specialized societies are currently cooperating with the Foundation's National Register of Scientific and Technical Personnel in the registration of scientists and engineers. Each major society serves as the registration agent for the particular scientific discipline it covers, and provides the Foundation with data on the individual registrant. Both society members and nonmembers are included. These societies also assist in the development of the classification of scientific specialties to reflect the current status of technological advances and carry on studies of scientists in their respective fields.

Several other organizations are active in the scientific manpower field from time to time. Notable among them are such agencies as the American Society for Engineering Education, Manufacturing Chemists Association, American Council on Education, the American Medical Association, and the McGraw-Hill Publishing Co., all of which have conducted surveys on scientific manpower in those fields of particular interest to them.

IV. THE NATIONAL SCIENCE FOUNDATION PROGRAM OF SCIENTIFIC MANPOWER INFORMATION

Program responsibilities

Responsibility for the scientific manpower information activities of the National Science Foundation is assigned organizationally to the scientific manpower program, one of five major sections of the Division of Scientific Personnel and Education. Assigned to this section are responsibilities:

1. To maintain the National Register of Scientific and Technical Personnel so that individuals with specialized scientific and technical skills may be identified, located and placed in priority assignments if national emergency conditions require it;

2. To provide data regarding the supply, utilization, characteristics, training, fields of specialization of and demand for scientific and technical personnel so that in the development of its programs the Foundation may consider the relevant factors of scientific personnel resources;

3. To provide a central clearinghouse for scientific manpower information so that other Government agencies, educational institutions, professional societies, private organizations, and other organizations concerned with scientific and technical personnel may have access to information required in administering their programs; and

4. To undertake a program of research in order to sharpen, improve, or discover methods of measuring the demand, supply, and characteristics of scientific personnel, and to develop a better understanding of the institutional framework in which scientists and engineers are employed.

The National Register of Scientific and Technical Personnel program

The National Register of Scientific and Technical Personnel is maintained so that timely information will always be available on the supply and professional characteristics of scientific personnel in important science fields. Operation of the register program makes it possible to have detailed information on science manpower resources in critical fields. Individual scientists with unique skills can be quickly identified and located during mobilization periods when the national interest so requires. An appraisal and evaluation of individual scientists can be made in relation to predetermined requirements. At the same time, a broad, overall view of scientists in our country can be obtained by aggregating the data on individuals into the statistical summaries. The National Register is the only comprehensive program for registration of scientists in the United States. Although the primary purpose of the register as it was first conceived was a device to identify and locate individuals possessing special scientific and engineering skills during periods of full or limited mobilization, the character of the register has been broadened to serve also as a source of statistical information useful in estimating supply, type and quality of training, functional distribution, and related data.

Historical development.—The need for mobilization of scientific talent in a national emergency became evident as early as 1863 when President Lincoln signed a bill creating the National Academy of Sciences for that purpose. At the time of World War I, President Wilson took a further step in establishing the National Research Council as the operating arm of the Academy. One of the first activities of the Council was the organization of a central professional register for locating specialized personnel for wartime research and development. It came too late in the war to serve its intended purposes but it provided valuable experience and a beginning for future efforts.

The mobilization activities that immediately preceded World War II included the establishment by Executive order in 1940 of the National Roster of Scientific and Specialized Personnel. The skills of more than a million American specialists, scientists, and technologists were ultimately registered in the National Roster. It was used as a placement service as well as a source of statistical information.

Established originally by the National Resources Planning Board and the Civil Service Commission, the roster was transferred to the War Manpower Commission in 1942. It was again transferred in 1945 to the Department of Labor where it was operated under the U.S. Employment Service until it became inactive in 1947.

Shortly thereafter, in 1948, the Office of Naval Research sponsored two studies of scientific and technical personnel which provided a basis for two selective rosters. A register of top scientific personnel listed 52,000 scientists. Some 65,000 engineers were registered in a register of engineering personnel, which was established by the Office of Naval Research with the assistance of the Engineers Joint Council in 1949. Unlike the previous roster, these projects were not used for placement purposes.

The National Scientific Register was established in 1950 in the Office of Education, largely as a defense measure during the Korean conflict. It was considered an interim activity pending the establishment of the National Science Foundation register.

Two specific references to the register were contained in the National Science Foundation Act which was approved by the President on May 10, 1950:

> SEC. 3. (a) The Foundation is authorized and directed—
>
> * * * * * * *
>
> (8) to maintain a register of scientific and technical personnel and in other ways provide a central clearinghouse for information concerning all scientific and technical personnel in the United States, including its Territories and possessions.
>
> * * * * * * *
>
> SEC. 14. * * *
>
> (i) The National Roster of Scientific and Specialized Personnel shall be transferred from the United States Employment Service to the Foundation, together with such records and property as have been utilized or are available for use in the administration of such roster as may be determined by the President. The transfer provided for in this subsection shall take effect at such time or times as the President shall direct.

On January 1, 1953, the National Science Foundation formally established the National Register of Scientific and Technical Personnel.

The registration process.—In previous rosters the collection of information on scientific and technical personnel was carried out by Government agencies with the use of Federal employees. An intensive

study of earlier experience in this field was completed by the National Science Foundation before it undertook the operation of the register. As one result of this study, the collection activities in the present National Register departed from earlier procedures in that the National Science Foundation provides financial support to the professional societies for undertaking the registration of qualified scientists. As presently conceived, the National Science Foundation contracts with eight professional scientific societies, each of which is responsible for a specific area of coverage. The eight contractors work with and through about 200 specialized societies in accomplishing this task. Registrations are secured by the societies, operating under common standards established by the Foundation. The scientific societies circularize individual scientists, members and nonmembers alike, to insure the most complete coverage possible. Information on each scientist is brought up to date every 2 years.

Fields covered by the National Register include broadly the life and physical sciences. Specifically, agricultural, medical, and biological scientists and psychologists are included in the life sciences. Physical science coverage includes chemists, earth scientists, physicists, mathematicians, meteorologists, and astronomers. Except for chemical and sanitary engineers, coverage of engineering fields is not such as to permit compilation of detailed characteristics information.

The societies currently contracting for the registration of scientists include: American Chemical Society, American Geological Institute, American Institute of Biological Sciences, American Institute of Physics, American Mathematical Society, American Meteorological Society, American Psychological Association, and the Federation of American Societies for Experimental Biology. About 175,000 names are now included in the register.

Information on the registrants relates to their training, employment, and specialized qualifications. Education and training, including degrees held and educational institutions attended, are reported. Present employment in terms of specializations, functions, salary level, and location is given for each registrant. Approximately 850 scientific and technical specializations are provided for the purpose of classifying each individual under as many as five different specialty titles. Language proficiency and area knowledge are among other items reported.

The National Academy of Sciences-National Research Council, under contract to the National Science Foundation, maintains a register of earned doctorates awarded by American universities. Through this mechanism, information is made available each year on new doctorates awarded, their fields of specialization, undergraduate and graduate training received, etc.

In 1953, the Foundation considered in detail the problem of including all (or a substantial fraction) of the country's engineers in the register it was initiating at that time. Representatives of the engineering profession advised against a register in engineering fields similar to the one being established in the natural sciences. Instead, a "finders list," which includes some 20,000 engineers representing different geographic areas and engineering specialties, was agreed upon as a device which would serve to meet the mobilization purposes of the register; this finders list was established and has been maintained. The key engineers whose names are included in this limited

roster agreed to supply advice on technical matters or names of other engineers with special talents, skills, and training to the National Science Foundation in case of emergency. This engineers' finders list is maintained by the Engineers Joint Council under contract with the National Science Foundation.

Early in 1959, the Engineers Joint Council, after having reexamined its earlier position, expressed to the Foundation its conviction that the time had come to evaluate the operation of the finders list and determine whether this device is still an appropriate registration procedure in view of its limitations in providing information on the characteristics of engineers. As a result, a contract was negotiated in June 1959 with the Engineers Joint Council under which the Engineers Joint Council will study (with other major engineering groups) the entire registration problem and report the views of the engineering profession. This report, with recommendations related to the desirability, feasibility, and methodology of developing a more complete national engineers register, is due by June 30, 1960.

The Foundation's decision to operate the register through the professional societies was made in 1952 after careful consideration of alternative courses. As originally conceived, the register was considered to be a cooperative venture taking advantage of the similarity of interests of the Government and societies in scientific manpower information. It was argued that (*a*) registration through the societies is more logical since most scientists naturally identify themselves with their societies rather than with a Government agency; (*b*) that the societies are in a good position to evaluate qualifications of individual scientists; (*c*) that societies are able to identify new specializations and emerging trends in their fields; and, finally, (*d*) that, because of their own interest in the findings of register studies, and because of the fact that societies must maintain mailing lists and other information on large numbers of scientists in connection with their own operations, the operation of the register through these organizations would be more efficient. These arguments were persuasive and have withstood well the tests of time and practice. The Foundation is convinced that the decision made at that time was wise, and considers the societies have served and will continue to serve the register effectively during periods short of a manpower mobilization situation. Under mobilization conditions, the program should immediately be shifted to fit in with emergency plans devised to meet those conditions; such plans are continually under review in connection with the general planning for an emergency.

The registration process has been maintained on a voluntary basis. Early reviews of the register program in 1952 and 1953 did not raise the question of compulsory registration. However, in late 1953 the National Labor-Management Committee and the Committee on Specialized Personnel of the Office of Defense Mobilization reviewed mobilization problems in some detail and submitted their recommendations in a report, "Manpower Program for Full Mobilization." Among these recommendations was the following one relating to the register:

> In peacetime, registration should be voluntary; under mobilization, it should be geared into any selective service or other manpower registration required for a broader purpose.

The Office of Defense Mobilization accepted the recommendations from its committees.

The National Science Foundation position is that compulsion in registration is unwise and unnecessary under peacetime conditions, in view of the kinds of uses to which the data are put; in a mobilization situation, however, registration of scientists should be geared into other more comprehensive registration programs, some or all of which may have to be made mandatory. This position was developed in more detail in chapter II.

Current status of the national register.—The Foundation has always considered, and other Government agencies have come to accept, the register as being the Central Government registration operation so far as scientific and technical personnel are concerned. For example, when the Public Health Service determined that a roster of sanitary engineers was required, arrangements were made with the Foundation to include such an operation within the broad framework of the register. Under this arrangement, the Public Health Service acts as one of the registering societies, and the records center includes the sanitary engineers as one of its component groups. A somewhat similar arrangement is being developed with the U.S. Civil Service Commission in connection with its roster of Government scientists and engineers. In the Executive Office of the President both the Bureau of the Budget and the Office of Civil and Defense Mobilization have from time to time supported the position that the National Register of Scientific and Technical Personnel should be considered the Central Government registration of scientific and technical personnel.

The Foundation has been pleased to cooperate with other Government agencies in making register information available to meet their special needs. In addition to the publication of register materials, a number of special-purpose tabulations have been prepared. These have been used for such purposes as providing information on selected scientific specializations, salary levels, and research employment as well as locating individuals with special qualifications. Generally, the Foundation will make available to other Government agencies information in the form of statistical summaries or punchcards. Individuals will be identified only where an urgent need exists, where other sources cannot be used, and where such use will not adversely affect subsequent response.

Information on the characteristics of more than 127,000 scientists was collected by the National Register of Scientific and Technical Personnel during the period 1954–55. Several analyses of this group were undertaken and detailed information on such factors as field of employment, professional specialization, type of employer, level of education, age, sex, and salary information was reported in "American Science Manpower, Employment and Other Characteristics, 1954–55." Other special publications included Scientific Manpower Bulletins Nos. 7 and 9 ("Employment Profile of Scientists in the National Register of Scientific and Technical Personnel, 1954–55" and "Foreign Language Knowledge of American Scientists, 1954–55").

In order to bring the information concerning scientists up to date, the Nation's scientists were recircularized in the fall of 1956 and collection of these data continued through the early months of 1959. The National Register received information on about 175,000 scientists during this period. During 1959, this information was reduced to microfilm and machine-punched cards, duplicate registrants were

50730—60——5

eliminated, and preparation for tabulations was completed. To expedite the processing of these and future register data, the National Science Foundation equipped a machine-processing activity as part of the National Register Records Center at North Carolina State College in Raleigh.

The availability of a large scientific population in the Raleigh-Durham-Chapel Hill area for assistance, if needed, was an important factor in determining that North Carolina State College should be asked to operate the National Register Records Center. The site selected takes into consideration such mobilization planning needs as the availability of communications, statistical, and research facilities. The National Register Records Center serves as the central records processing and storage center for the register operation.

Special tabulations of the 175,000 scientists included in the 1956–59 register have been prepared showing such information as: a frequency count of scientists according to competence in each of some 850 scientific specialties, and of scientists according to proficiency in 64 foreign languages. Currently underway are final tabulations on such factors as scientific specialization, salary, level of education, type of employer, and age. It is expected that an analysis of these data will be published by June 1960.

1960–61 register program.—Register operations beginning in the National Science Foundation in fiscal year 1954 collected information on some 127,000 scientists and engineers by the end of calendar year 1955. Registrations increased to about 190,000 in fiscal 1959, and will reach an estimated 250,000 in 1960.

Plans are now underway to recircularize registrants according to the 2-year cycle plan. Revised questionnaires and specialties lists, as well as a brief report on the 1956–59 data, will be mailed to qualified scientists starting in the spring of 1960. It is anticipated that some 280,000 individual scientists and engineers will be registered by the end of fiscal year 1961.

The following table provides detail on estimated registrations by society:

National Register of Scientific and Technical Personnel—Estimated registrations by cooperating societies

[In thousands]

Society	Registrations end of fiscal year		
	1959	1960	1961
American Institute of Biological Sciences	23	28	30
Federation of American Societies for Experimental Biology	14	20	21
American Geological Institute	20	25	25
American Institute of Physics	22	30	32
American Meteorological Society	5	5	5
American Psychological Association	15	18	18
American Mathematical Society	15	18	18
American Chemical Society	50	55	60
Engineers Joint Council	20	25	25
U.S. Public Health Service [1]	6	6	6
U.S. Civil Service Commission [2]	0	20	20
New applied science fields [3]	0	0	20
Total	190	250	280

[1] Considered cooperating society for registration of sanitary engineers.
[2] Considered cooperating society for registration of Government scientists and engineers (GS–13 and above).
[3] Will include selected applied scientific fields such as aeronautics, and rockets and missiles.

Increased emphasis will be placed on the registration of scientists in such fields as aeronautics, rockets, and missiles. Also, efforts will be increased to include additional coverage in the more traditional scientific fields, such as biology, physics, and chemistry. With the current availability of the tabulating equipment at the National Register Records Center, plans call for the data collected starting in the spring of 1960 to be processed expeditiously, in order to have available preliminary information by the end of calendar year 1960.

Special requests for information related to specified characteristics are becoming more numerous as a result of increasing public knowledge of the wealth of scientific manpower information available in the Register. Recent examples have included: scientists with knowledge of foreign languages for scientific translations service; qualified specialists to review research project proposals or serve on various types of advisory committees; scientists located in certain geographical areas; scientists with specialized professional knowledge of epidemiology or certain branches of geology, and familiarity with certain U.S. or foreign areas, etc.

In addition, requests for special analytical tabulations are increasing. Examples are: comparative salary tabulation for the U.S. Civil Service Commission or other Federal agencies or State governments; supply and distribution of scientists within a given State with reference to establishment of a research center; and nationwide supply and distribution of certain specialists with reference to feasibility of proposed new research projects or facilities.

The present system of classification of scientific and technical specialties was developed in connection with the 1956–58 circularization and will be revised for use in the spring of 1960. Each scientific society has been requested to review those specialties applicable to its discipline and recommend possible changes in them. It is anticipated that only minor modifications will be necessary to take into account important new developments at this time. Plans are being made for a continuing program to develop a scientific and technical specialties system appropriate for use in future circularizations.

A brochure describing the functions and programs of the National Register of Scientific and Technical Personnel is being prepared for general distribution. This booklet will be made available to industrial firms, private groups, academic institutions, Government agencies, and to the general public. A description of the history, objectives, operations, techniques and services of the National Register will be useful both to registrants and users of its information.

The general character of the National Register has been evolving as the requirements placed upon it have been modified. As previously pointed out, its chief function was initially considered to be the identification and location of highly specialized personnel under emergency conditions. Performance of this function implied stress upon selectivity in register coverage and emphasis upon a highly current address system. Close cooperation with Government agencies concerned with manpower mobilization activities was a paramount consideration. Without denying the continuing importance of this function, the Foundation has come to accept that there are other important register functions concerned with the provision of information on science manpower resources for the purpose of program planning and evaluation. These kinds of uses place great importance upon broader

coverage of scientific personnel, its utilization, and relation to requirements. In short, the register program is an evolving one which should be kept sufficiently flexible to meet new requirements for scientific manpower information as they develop.

Scientific manpower studies program

The principal responsibilities of the scientific manpower studies program are: (1) to provide for the collection and analysis of data regarding scientific and technical personnel; and (2) to provide a central clearinghouse for scientific and technical manpower information. A recently assigned responsibility is that of acting as a "focal agency" within the Federal Government for scientific manpower information. This responsibility, assigned by the Bureau of the Budget, calls for establishing priorities for specific projects, programing them to insure that they are coordinated and that a coherent body of timely information can be produced and analyzed, and publishing information from the many parts of the Federal Government in convenient form. In the performance of this function, the Foundation will assume a larger role in Government surveys and studies of scientific and technical manpower and will undertake to provide leadership in the development of such programs.

General program operations.—Scientific manpower studies, as the Foundation's unit which has responsibility for scientific manpower studies, has attempted to fulfill the clearinghouse function by making existing information available. In 1955, for example, "Scientific Personnel Resources, a Summary of Data on Supply, Utilization, and Training of Scientists and Engineers" was published. Since then several scientific manpower bulletins and studies have been released, dealing with more specialized aspects of scientific manpower. Furthermore, it was possible to provide support for some new studies and surveys.

In fiscal 1959, some additional funds were provided to permit the further development of data needed to evaluate programs designed to improve the Nation's scientific manpower potential. This higher operating level has been continued in fiscal 1960. By fiscal 1961, it is hoped that the basis for a broad coordinated program of scientific manpower data collection can be further developed.

The Foundation's scientific manpower studies activity uses information collected by other organizations, both private and public, as well as data developed within the Foundation to carry out the basic function of maintaining a "clearinghouse of information." This involves the collation, review and further—specialized—analysis of materials originally collected by the Office of Education, Bureau of Labor Statistics, Bureau of the Census, National Education Association, National Research Council, and many other governmental and private organizations concerned with one or more aspects of scientific manpower or the collection of information.

This review and analysis of scientific personnel information frequently reveals certain data inadequacies. This circumstance is a natural corollary of the conditions under which the data are compiled. In the past, scientific manpower data have typically been collected as a part of either a general purpose study or as incidental to a study focused on other topics. Collection of information on the population of engineers through the decennial census of population is an example

of the former, while the collection of information on academic degrees granted in science typifies the latter. This situation could not be expected to lead to entirely satisfactory information; as the Foundation has discovered deficiencies in available data, it has attempted to obtain better information through a variety of additional mechanisms. This sometimes has required direct collection, but more frequently has led to the Foundation providing assistance to other organizations in their collection efforts. Each of these methods has been used on occasion.

The Foundation believes a continuing effort should be maintained and strengthened to overcome the major deficiencies in scientific and technical personnel information. Resources available to this program, though they have been increasing, are still not sufficient to do more than concentrate on the most pressing needs. Consequently, data on our scientific and technical personnel resources are inadequate in such important areas as: detailed and precise estimates on numbers and kinds of scientists and engineers, the functions at which they are employed, measures of demand for their services, factors influential in the selection of scientific careers, etc. This lack of detailed and reliable information is a serious handicap to the development of programs aimed at expanding our scientific potential.

In general, the current programs in scientific manpower studies are directed at implementing specific projects which are in accord with the series of studies recommended in the Foundation's report, "A Program of National Information on Scientific and Technical Personnel." This report was prepared in answer to a Bureau of the Budget request for the development of such a coordinated program and has been endorsed by virtually all the groups—Federal agencies and others—who have an interest in this type of information. It has also resulted in the Foundation's responsibilities as the "focal agency" for scientific manpower data collection mentioned above.

Specific program areas.—The Foundation's program of scientific manpower studies thus is focused on the major elements of scientific manpower information described in the preceding chapters—supply, demand, training, and utilization. This general plan has been followed in fiscal 1959 and 1960, and will be continued in the immediate future. Some of the specific projects included in the current programs are:

With respect to supply:

1. The establishment of a collection effort to obtain, annually, data on the supply of scientists, engineers, and related personnel employed in three major sectors of the economy. This is to be done through the National Science Foundation support of surveys by the U.S. Bureau of Labor Statistics of employment in industry and State and local governments and the U.S. Office of Education of employment in institutions of higher education, and through cooperation of the Civil Service Commission for employment in the Federal Government.

2. The Foundation has contracted with the Bureau of Social Science Research of Washington, D.C., to provide a detailed picture of the occupational status of 1958 college graduates within 2 years after graduation and to obtain information on the further progress of these graduates through the educational system. This study will thus supply needed data in the areas of supply and utilization of college

graduates in all fields and will focus on the beginning career patterns of young graduates.

3. Salary and income data are among the most frequently requested types of information on scientific personnel. Several studies of this type have been supported in past years, including one on engineering faculty earnings by the Engineers Joint Council in 1958. Efforts in this direction will be continued in 1960 and 1961.

4. Additional information is needed on the extent to which youth trained in science and engineering subsequently select either technical (i.e., scientific or science-related) or nontechnical careers. Similarly, data are lacking on the kinds of training received by those actually employed in scientific and engineering fields. An effort to obtain this information through followup analyses based on data collected in connection with the 1960 Census of Population is proposed. The project would consist of a special survey of a sample of persons recorded in the 1960 census as college graduates or as persons currently or last employed in scientific and technical positions. The information collected through this means should supplement that from less extensive followup surveys of college graduates from other sources.

5. Better information than is now available is needed on the factors associated with the choice of scientific careers and methods of identifying students whose abilities would enable them to become creative scientists and engineers. The Foundation has sponsored for several years conferences on the identification of creative talent. These conferences have brought together persons engaged in such research to enable them to discuss and coordinate efforts in this area. At present, the Foundation is supporting a study of the childhood characteristics of Harvard University graduates, particularly those who have entered scientific and technical careers. A limited amount of additional work in this area is being planned in fiscal 1960 and 1961.

6. The Foundation has agreed to a request by the Office of Civil and Defense Mobilization to assume responsibility for a limited program to carry out periodic assessments of the relative positions of the free world and the Soviet bloc nations with respect to scientific and technical manpower. Furthermore, the programs of the Organization for European Economic Cooperation, the European Productivity Agency, and NATO in this area have resulted in more requests for assistance and information on scientific manpower problems. The Foundation is currently supporting the National Research Council in a revision of the report, "Soviet Professional Manpower," which was produced several years ago. It is also supporting the Library of Congress in a study of professional manpower in Communist China and is working with a number of other Government agencies and organizations on the collection and assessment of information on scientific personnel resources in foreign countries. Additional studies along these lines are planned for fiscal 1960 and 1961.

With respect to demand:

7. The Foundation is supporting the U.S. Bureau of Labor Statistics in a pilot study of demand for scientific and technical personnel in industrial concerns. The present project consists of two parts: detailed studies of long-range demand in two major industries, and long-range projections (10 years or more) of demand in the entire

economy. This latter part will provide a first approximation of future trends as well as a framework for future intensive study of particular segments of the economy. Additional pilot studies will be carried on in this most important segment of scientific manpower information.

8. The Foundation is currently supporting the U.S. Bureau of Employment Security in a series of periodic reports of labor market conditions for scientific and technical personnel in selected labor market areas. Data from employers and other organizations in each area, and information from the public employment offices affiliated with the Bureau in the several States are being analyzed to provide a picture of the demand-supply balance in these areas.

With respect to training:

9. The Foundation is supporting the U.S. Office of Education in the collection of information on the enrollment of students for advanced degrees. This study will provide information on the number of persons at several stages of graduate education in scientific disciplines.

10. The U.S. Office of Education is being provided financial assistance to permit it to expand a study regularly carried out by it on Federal Funds for Education; the additional support from the Foundation will enable it to provide a special analysis of Federal funds for science education. This study is a first attempt to determine the amount of Federal support of activities at all levels of education which involve student-teacher relationships, including the combined research-education projects in our colleges and universities.

With respect to utilization:

11. The Foundation is supporting the Mathematical Association of America and the U.S. Bureau of Labor Statistics in an experimental study of nonacademic mathematical employment. This study will seek information from employers in industry and Government of persons who were trained in mathematics or who are engaged in mathematical work. The resulting report will provide information on the training of such persons, the working relationships of these individuals to persons in other scientific fields and the utilization of mathematical training in their jobs.

With respect to reporting concepts generally:

12. The Surveys and Research Corp., of Washington, D.C., working under contract, is making a pilot study of reporting definitions and concepts of scientific and technical personnel employed by industrial concerns. An ultimate goal of more extended studies and efforts will be to attain a degree of standardization in the use of occupational titles and classifications. This would make possible more reliable national data on scientific and technical personnel and simplify some of the reporting problems which are particularly serious in this field.

The results of the scientific manpower studies activity become available in several ways. When appropriate, findings are published as Foundation documents; on occasion, results are released by other agencies as studies supported by the Foundation. (See appendix B for a list of such documents.) Numerous memorandums are prepared in response to requests for specific and detailed information on special topics. Similar materials are frequently made available for inclusion in speeches and articles bearing on the problem of scientific and technical personnel.

V. A LONG-RANGE PROGRAM OF SCIENTIFIC MANPOWER INFORMATION

General considerations

The planning of a long-range program for obtaining information on scientific manpower must take into account assumed long-range program objectives in the absence of specific goals for recruitment, training, and utilization of such personnel. Such a program must be sufficiently flexible to adapt to unforeseeable future requirements, while still furnishing general guidelines for action. This implies that in some areas the program should be suggestive, rather than definitive. Such a program must provide needed flexibility so that it can be modified, when appropriate, to take advantage of promising new leads or to meet newly determined goals.

Since the needs of Government for scientific manpower information are in some respects most easily identified, a program to meet these needs should have high priority. This does not mean, however, that the needs of others should in any way be overlooked or underemphasized. Frequently, the Government interest may be served best by placing significant and timely information in the hands of industrial, university, and other groups.

The term "long-range programs" (in an area as highly dynamic as scientific manpower) is likely to prove misleading unless properly interpreted. Events may move so swiftly that "long-range" plans of last month may become the current program next month. Although this is a possibility, it is quite unlikely that a well-designed program will become obsolete so rapidly, however. It seems reasonable to conclude that an appropriate "long-range" program in this field should be directed toward goals which give promise of at least preliminary results within the next 5 years, or by 1965. The proposed programs should be subject to continual review, and by 1965 should have been reexamined and rejustified in detail.

A final general consideration is the matter of cost of a serious scientific manpower program. The extent to which the long-range program can be accomplished is dependent in the last analysis on the amount of money available to support it—specifically, the amounts the Federal Government makes available for this purpose. Even the most carefully planned program will be ineffective if necessary funds cannot be committed for its implementation. There seems to be little hope that the substantial financial support required will be available from any source other than the Federal Government.

Considerations underlying the program

Anyone hazarding an assessment or planning a program for the future faces the necessity of starting with certain basic considerations or assumptions. They may be either implicit or explicit. It seems desirable that those underlying the proposed scientific manpower information program should be explicit.

The first series of assumptions relates to the extent of future involvement of the Federal Government and the public in scientific manpower

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problems. Since an information program is justified in terms of needs, it is proper that these needs be assessed.

It is confidently expected that both Government and non-Government concern with scientific manpower matters will continue to increase through the next 5 years as it has in the past. A direct involvement in a major war, whether nuclear or conventional, would place an unprecedented strain on the training, recruitment, and utilization of scientific personnel. Increasing international economic competition if cold war tensions are relaxed will put similar, although less spectacular, pressure upon research and development, production, and training with their own science manpower implications. Either of these alternatives will be accompanied by expansion in Government support of scientific research, development, and training programs, which are now in the neighborhood of $8 billion annually.

It is possible that neither a war ("hot" or "cold") nor an economic conflict will face the Nation over the next 5 years—but such a possibility seems quite unrealistic. If such should be our good fortune, one would expect a rapid economic expansion. It would be based on technology, and the development of new products growing out of scientific discovery would be a chief characteristic. Its requirements for a scientifically trained work force probably would be only slightly—if any—less than under the more probable alternatives. Such a development might result in the substitution of more diverse motive forces, but it would not reverse the science and engineering orientation of the economy. Therefore, under any reasonable view of the near future, it can be assumed that there will be greater rather than less concern with such matters as the volume of research and development, the extent and quality of the training given to our scientific personnel, the ways in which the supply is being used, their numbers and specializations, recruitment—in other words, the problems of scientific manpower will continue to require adequate and accurate information for their solution.

A second series of considerations applies to the character of the Government's mechanisms for the collection, analysis, and dissemination of information. As previously noted, the U.S. system of statistical and economic intelligence is a decentralized one. Those agencies which have important program responsibilities in a given area are generally made responsible for data development in that area. Since program responsibilities tend to follow such functional lines as education, labor, business, etc., it follows that information collection activities focused on different aspects of the same general subject may be administered by different agencies. Scientific manpower is one such subject. This system is assumed to be the general pattern which will continue to evolve over the next several years. It is further assumed that non-Government agencies, such as universities, professional societies, research institutes, and the like will continue to make important contributions to studies and research on these topics.

The principal program areas

For convenience of treatment, the proposed long-range program of scientific manpower information is outlined in terms of the principal program areas enumerated previously. They are the supply, the demand or requirements, training, and utilization. The report of the Special Advisory Panel to the National Science Foundation and

the President's Committee on Scientists and Engineers referred to above is especially pertinent here. The document developed from the report, "A Program for National Information on Scientific and Technical Personnel," is the source for much of the section which follows. Emphasis is changed in some respects, and less detail is provided. However, the major elements of the program are similar.

The supply of scientific manpower.—The effort to provide full information on this topic will assure adequate coverage of: information on the resources of scientific personnel; their professional and economic characteristics; their deployment by industries, occupations, locations, and functions; and levels of qualifications in terms of training, experience, and measurable innate abilities. It is concerned with potential supply as well as present supply and the factors important in determining both of these. Part of the picture is the development of an adequate frame of reference to relate scientific manpower resources to its institutional surroundings in terms of population, labor force, extent of financial support, training requirements, etc.

The translation of these information needs into program actions will go well beyond present efforts. Several different studies and approaches will be involved.

The first such study should be an annual estimate of the numbers of scientific and technical personnel derived from reports of employing establishments. This represents an extension of the present limited estimates, and would be based upon appropriate sample techniques. Data would be collected from industry, educational institutions and Government agencies—Federal, State, and local—on an annual basis; smaller or less volatile employing segments would be called upon for information at 2- or 3-year intervals. Resulting information would include numbers by broad scientific and technical fields, functions performed, industries and activities in which employed. Detailed characteristics data would not be sought through this mechanism. Its great value would be wide coverage which quickly gives an estimate of the totals and trends of growth and utilization for these professions.

A second major facet of this program is the extension and development of data from the National Register of Scientific and Technical Personnel. This mechanism, as the currently unsurpassed source of characteristics data, would be exploited for its contributions to detailed scientific specializations, experience and training, personnel characteristics, salary and income, foreign language and areas knowledge, and combinations of such information. In order to improve the precision of this group of studies, a serious effort must be launched to expand coverage in those disciplines now included within the scope of the register so that adequate statistical representation of professional personnel can be assured. (This level of coverage has previously been indicated as approaching 90 percent.) To this coverage would be added at the minimum those applied and other scientific disciplines which are determined to be critically important to national programs. Currently these are considered to include metallurgy, crystallography, ceramics, rocket technology, and aeronautics. As new fields become critical, each would be examined to determine the feasibility and desirability of inclusion within the register. Scientific manpower information of general interest would be issued on an annual basis by the register; special analyses and tabulations would be prepared to meet important immediate needs as they arise.

A third principal source of information is a proposed followup sample survey based on the 1960 Census of Population. The census itself will yield many useful statistics on scientific manpower (including social sciences); however, since the census is a general-purpose project, highly detailed technical information on scientists and engineers will not be provided. The survey involves using the 1960 census schedules as a base listing from which would be drawn names and addresses of persons reported in selected occupations. These persons would be sent questionnaires requesting more detailed information than was obtained in the census. Through such a survey, valuable data can be acquired economically and efficiently concerning the kinds of training received by scientists and technical personnel, and their demographic, economic, and social characteristics. Considerable information can also be obtained concerning sources of potential increments to the supply. For example, information would be provided on the characteristics of scientifically trained persons who are unemployed or who have left the science labor force through retirement or transfer to nonscience occupations. Among the survey's unique contributions would be the information it would provide on the employment and training of technicians—regarding whom little is known—and the sample inventory of engineers it would yield. It is also proposed to include in this survey all types of college graduates; this would yield, among other valuable results, a very useful perspective on the place of scientific personnel in the total highly trained manpower field by providing comparable data on such other vital groups as those in the humanities, other professions, business, and government administration. With reference to the National Register, this survey would provide (1) a singular opportunity for evaluating the overall coverage of the register, and (2) a possible means of developing an alternative to the proposal to establish a register for engineers. Although periodic sample surveys of the population might be undertaken in later years to supplement and bring these various types of information up to date, the first step is to utilize the 1960 census material. Because effective and efficient implementation of the proposal requires close liaison with the 1960 census program which is well underway, the Foundation is now taking the leadership in developing and evaluating plans for this project.

To these three central studies should be related a series of relatively smaller surveys designed to round out the scientific manpower supply picture. Most of them might be undertaken on an occasional basis or as a part of a more inclusive data program.

In this latter category are research studies designed to measure the potential supply of scientists and engineers. Investigations into the distribution of youth in terms of mental abilities and aptitudes, their attitude toward science, and the factors important in occupational choice as they concern science careers are important in estimating potentials. Occasional studies of the relationship between formal science training and subsequent employment choice can provide estimates of the degree to which we are fully utilizing our potential supply.

Another area of some importance in the supply picture is that of immigration and emigration. The extent to which our scientific manpower supply is augmented from this source can be determined on a recurring basis through the immigration statistics. At least a one-

time measure of emigration loss should be developed to determine its relative importance.

Other information with important implications for supply will be treated in the section on training.

The demand for scientific manpower.—Perhaps the most deficient information area is that of the demand for scientists, engineers, and technicians. This deficiency stems from the lack of an accepted rational basis from which to prepare current estimates. It is generally agreed that high priority should be given to research directed toward developing the techniques useful in such estimates. Such a research effort should examine into the relationships of past scientific manpower employment—as the reflection of demand—to other phenomena, such as gross national product and income, total and professional employment, research and development expenditures, etc. From such analyses it is hoped that more timely and accurate demand estimates can be prepared.

In the meantime, there are other measures of demand which can serve many purposes. Periodic surveys of job vacancies and employers' hiring plans are useful in identifying current and near future shortages by occupations, industries, and areas. Such surveys, covering principal employing segments of scientific personnel, should be undertaken on about a biennial basis. Reports of placement services can be developed to indicate general magnitudes of demand-supply relationships. A continuing surveillance over such matters as the development of new scientific installations, the application of newly discovered scientific principles to industrial production, and the initiation of new sources of science support is important in detecting demand trends in specialized areas.

No impression should be given that precise future estimates of scientific personnel requirements will eventually be possible, or even necessary. In this highly dynamic field, it has become trite to say that the research scientist creates his own demand. Yet this is true in the sense that with little warning, a new field can bourgeon forth as the result of new breakthroughs. Such developments can probably never be predicted as to time and place. However, after a breakthrough occurs, it becomes important to gage its significance in relation to the supply of scientific manpower and the implications for future training. For these purposes, great precision is not required, although direction and general magnitudes are important.

Education and training information.—Included under this topic is a complex of information dealing with the extent and character of the science manpower training process, its facilities and financing, and the faculty and students giving and receiving training.

At the graduate school level of training, present information on numbers of degrees granted in science should be extended to include data on graduate enrollments in the natural and social sciences. As a minimum, disciplines in which principal training is taken, its full- or part-time character, and level of training should be compiled. This type of information will greatly assist in the assessment of the future supply situation. Periodically, a special survey dealing with the financing of graduate education, sources and types of support by disciplines, and extent of graduate offerings should be undertaken to determine the availability of such training to qualified students.

At the undergraduate level of science training, the development of science enrollment data on a basis comparable with engineering enrollments, investigation into the extent and causes of student dropouts during the training process, and occasional studies of course content and academic practice relating to the designation of science majors fall properly within a scientific manpower information program. Ability levels of students selecting science training should be evaluated in relation to competitive subjects to determine the relative attraction of science training. What might be called the economics of science training should be periodically reviewed to determine whether costs are preventing substantial numbers of high-ability students from undertaking such training as well as to determine whether adequate resources are available to provide quality training.

At the secondary school level, emphasis should be placed on measuring the extent of student exposure to science training, the nature of science courses offered, and the facilities and resources available for such training. Private schools should be asked to provide data comparable with that of the public schools. Since it is during these formative years that the decision for a science career is usually made, research should be directed toward the relationship of the school to student attitudes and occupational choice.

Relatively little information is available on science training at the elementary school level. As a beginning, facts must be collected as to its extent and character. The age at which career choice decisions are made has important implications for elementary school science. Research work in this area must be accelerated.

The quality of science training is chiefly determined by the instructional staff and the availability of instructional facilities and equipment. At all levels of instruction there is insufficient information on those who teach—their level and quality of teaching, their employment conditions, and the extent of their nonteaching responsibilities. Not enough is known concerning the investment in, condition of, and requirements for replacement of science instruction facilities and equipment. These are among the areas important from the standpoint of developing adequate information on the training of science manpower.

Another universe of formal training exists outside the regular college-university system. It includes industry- and Government-sponsored programs, which frequently provide employee training at the levels of graduate and undergraduate science instruction. A survey devoted to this topic should produce information on the magnitude and character of such training, which is believed to provide a major supplement to the educational system.

Utilization of scientific manpower.—As the competitive demands for science manpower increase, the improvement of utilization practices may be the most practicable method of meeting them. In the absence of—and probable impossibility of—generally applicable and meaningful standards of good practice in this regard, any information program requires research and tentative approaches.

It is suggested that an initial program should be developed around case studies of typical situations. An examination of some of the different occupations typically filled by science-trained personnel would make a beginning. Each respondent would be asked to report his activities in terms of relevance to his science training. As patterns

emerged from a series of case studies of a given occupation, implications for improving the utilization of given groups would become clearer than at present. It is probable that generalizations could be formulated only after numerous such case studies have been conducted.

Information on science manpower and support personnel ratios, gross measures in themselves, have a value in reflecting current practices. Such ratios are readily derivable from the studies of current employment noted above.

Finally, information should be secured on changing utilization patterns. Such phenomena as the substitution of engineers for scientists in the conduct of research, the use of engineering technicians, the extent to which improved scientific equipment and facilities multiply the scientists' efforts, and improvements in science information dissemination are among the factors important in determining the levels of manpower requirements.

Implications for the National Register of Scientific and Technical Personnel

The role of the register in supplying information on the supply of scientific personnel has already been discussed. In order to fulfill this responsibility, approximately 90 percent of the scientists in presently covered fields should be registered. Furthermore, certain applied and other science fields should be covered as the need arises. Substantive information on employment and professional characteristics will be brought up to date at not longer than 2-year intervals.

The register's principal past weakness has been the delay in collection, processing, and publication of the information developed from it. Too much time elapsed between the time the scientists were requested to supply registration materials and the date on which analyses were available. While this weakness was principally the result of insufficient funds available to support the operation, delay on the part of many scientists in supplying information was part of the problem. Since the expansion of the data processing activities in 1959, the register tabulation program has been greatly expedited. Future plans call for currency in address and characteristics information, and annual release of data collected.

The extent to which professional engineers generally should be included within the register is a serious problem. Engineers are to be found in a wide variety of jobs ranging from those requiring the highest levels of scientific creativity to those involving relatively routine technician-type tasks. Their training varies from the postdoctorate student to some who did not complete secondary school. They are widely scattered throughout many industries and occupations. There are now an estimated 850,000 engineers in this country—a number much greater than the number of scientists. Further, about 40,000 new engineering graduates at the baccalaureate level are being produced each year. Techniques appropriate for the registration of scientists may be less satisfactory for engineers. In spite of the serious problems involved in any mass registration of engineers, the desirability of better information on their numbers and characteristics is unquestioned.

In view of the complexities of this problem, the Foundation has turned to the engineering profession for its advice. A contract

between the Foundation and the Engineers Joint Council will result in a report embodying the recommendations of the profession on this subject. This report should be received by the middle of 1960, and can be taken into account in the 1961 program.

The Foundation believes it should not take a final position on the question of initiating a comprehensive register of engineers until the views of the profession are received. Certainly, so long as the register operation is conceived as a cooperative venture between Government and the professions, the engineers themselves should be allowed to formulate and express their views as to the character of any register effort. At the same time, the Foundation recognizes there is a need for improved information on the Nation's engineers and should undertake to provide it through the register operation or in other ways.

It is also clear, of course, that the needs of Government may not always coincide with the wishes of all groups of its citizens. After the recommendations of the Engineers Joint Council study are received, the Foundation expects to review them in relation to the Government's needs for information on engineers. After such a review has been completed, the Foundation will plan a program to meet those needs which are of a priority order.

The register will continue to service the needs for the identification of and location of individual scientists as required for tasks of national importance. Such uses will be encouraged during normal periods, in order that experience will be gained for such use during a national emergency. This type of service will require greater attention to currency of information. Methods will be sought to maintain address currency within 1 year, and other information within 2 years. Procedures will be adopted to provide register information at selected decentralized locations for use under emergency conditions.

A program to encourage improved register response will be promoted. Through wider dissemination of register information, showing the individual registrant the results of his profession's cooperation, developing the mobilization role of the register, and identifying scientists with the register, an improved rate of response should be achieved.

The Role of the National Science Foundation

Largely as the result of the Foundation's activities over the past 6 years, a great deal more is known about scientific and technical personnel than previously. Register data have been published and in other ways released to provide information on science manpower resources in specialized areas, levels of training, kinds of employers, functions performed, salary levels, foreign language knowledge, etc. Periodically, estimates have been released on the total number of scientists and engineers, and the numbers engaged in research and development activities. Our education statistics have been improved to provide greater detail on fields of earned degrees, undergraduate majors in science, science faculty, and the baccalaureate schools at which science doctorates earned their first degrees. From time to time, comprehensive data are released covering a topic which is particularly timely; e.g., manpower resources, education and training, or Soviet manpower in specialized fields. Finally, special studies and analyses have been made on such topics as the short-run demand for scientists and engineers, projections of supply, women in science,

and others. An annual conference on scientific manpower has resulted in publication of numerous thoughful papers. (See app. B.)

It has been pointed out that a program of scientific manpower information involves the cooperation of a great many different agencies. Several agencies are engaged in collection of different parts of the current program; the proposed program will continue this pattern.[1] Agencies with collection experience or program responsibilities in specialized fields should be looked to as the science manpower information producers for those fields. In this way, advantage is taken of existing collection mechanisms and skilled personnel. Building up overlapping staff agencies can be avoided.

The parts of this proposed program which should be the responsibility of the National Science Foundation are a logical extension of its present program. Further development of the National Register of Scientific and Technical Personnel to make it a more effective vehicle for characteristics information on scientific personnel and for identification of individual scientists has already been noted. A second important area of operation is that of meeting requirements for scientific manpower information in connection with the Foundation's own program planning and evaluation. Where such information is available from other sources, it is used; frequently, however, it is not so available or requires further analysis and treatment to adapt it to Foundation needs. The third area of Foundation concern is the continuing support of scientific manpower projects being carried out through other agencies, Government and non-Government. As the Foundation clearinghouse function identifies important data gaps, it seeks to fill them, frequently through support of other agencies. There is a continuing requirement for support in newly emerging areas; it is expected that requirements for recurring programs will eventually become the responsibility of the performing agencies. A fourth area of the Foundation's operations should be the very important one of the development of improved techniques for preparing scientific manpower reports, analyses, and projections. A program of fundamental research into methodology is most desirable, and is required for real progress. The lack of an adequate conceptual framework has been a basic problem in preparing estimates of demand, for example. Other topics requiring attention include the development of reporting definitions and concepts, and preparation of a broad classification suitable for science manpower purposes generally.

The multiagency collection system requires a central coordinating agency for effective program development. Attractive as the assignment of program operations to those agencies best qualified to perform them is in theory, central coordination is necessary to weld the discrete parts into a harmonious whole. Each agency individually is likely to emphasize those parts of the overall program which will assist it individually; less importance is assigned to the parts of primary interest to other agencies. A central agency with an ability to view requirements broadly and impartially is required for effective operation.

The National Science Foundation has been determined to be the appropriate agency to perform this coordinating role in the scientific

[1] See ch. III: Agencies Engaged in Scientific Manpower Information Program Activities. In the appendix will be found further suggestions of programs of particular interest to different Government agencies.

manpower information domain. It occupies a central position among the Government science agencies in its support of basic research. Its programs for the support of training of scientific manpower spearhead the Government's efforts in this area. Its statutory responsibilities include provisions for maintenance of a clearinghouse of information and operation of a register, which is one of the principal information sources under any program. Finally, the recent action of the Bureau of the Budget in asking that the Foundation act as the focal agency in this regard lends the support of that agency to this position.

With the advice and assistance of the other agencies, the Foundation should develop the details of the broad program outlined here. As the coordinating agency, the Foundation has a particular responsibility for the development of appropriate standards and definitions suitable for the program. Pioneer work in developing a classification system for scientific manpower specialties started by the Foundation and cooperating professional societies should be extended with the view of an ultimate system for governmentwide use. The Foundation must assume an increasing degree of responsibility in the determination of priorities for new projects, since it is not to be expected that all conceivable components of a complete program can be activated simultaneously. Publication of results should be made as promptly as possible; however, republication of summaries in the form of yearbooks or comprehensive fact books should be a responsibility of the coordinating agency. Finally, the Foundation must have the necessary means to carry out its own operating program plans, and to provide support for the programs of other agencies where this is necessary to secure urgently needed information.

Estimated cost of the proposed program

It has not been possible to estimate the total costs of the proposed program. National Science Foundation costs for the present limited program are approximately $900,000 per year including both the register and manpower studies programs. The proposed program would be built up in stages over the next several years and would reach about $2 million per year by not later than 1965. At this level no financial provision is made for the addition of large additional coverage within the register, such as would be involved in any general coverage of engineers.

Since it is proposed that decision as to the character of an engineers' register be postponed until after the recommendations of the engineering profession are received, no separate estimate is proposed for its cost at this time. After the report of the engineering profession's recommendations has been received, and the Foundation determines its program in this regard, a separate estimate can be prepared. If all engineers are to be registered on a basis equivalent to scientists in the National Register, however, registrations will be multiplied by perhaps five times. At this level, the register program would cover all the traditional engineering fields, including civil, mechanical, industrial, electrical, etc., and would probably require an annual expenditure between $2 and $2.5 million alone.

Recommendations for legislation

The National Science Foundation has reviewed its statutory authority as it related to its register and clearinghouse functions and believes additional authority in two respects would be desirable.

The National Science Foundation Act of 1950, as amended, does not make specific provision for financing the register and clearinghouse functions through the grant mechanism although use of the grant is more appropriate in particular cases, as when dealing with a professional scientific society or a university. It would be helfpul for the Foundation to be encouraged to use grants, where appropriate, in sponsoring and supporting studies and research in this area. A Government contract for a research study carries certain implications of purchase of findings which has sometimes made research organizations reluctant to enter into a contractual relationship with the Foundation. Research in this area, moreover, may be as basic in method as that supported by grant under other Foundation programs. The Foundation, therefore, recommends a change in section 3(a)(8) to authorize specifically the support of register and clearinghouse operations through grants, or otherwise, as may be appropriate in each case. Such a language change will provide specific authority for support of the register and clearinghouse activities in a manner similar to the authority the Foundation now has with respect to support of other scientific activities.

A second area in which legislation would be useful concerns the scope of the register and clearinghouse coverage. There are certain specialized fields—not strictly scientific or technical—which may be quite appropriate for register-type treatment. Examples are the foreign area and language specialists who are currently in short supply and who would be particularly important in emergency situations. Persons possessing such capabilities with respect to many of the lesser known but highly important nations of the world are relatively rare, and information on them is not readily available. The Office of Civil and Defense Mobilization and the Department of Defense have specifically requested expansion of the register to include such persons. The Foundation recommends, therefore, that consideration be given to further amendment of section 3(a)(8) to permit coverage of selected specialized personnel.

The Foundation, in the near future, will submit proposed language for effectuating these recommendations.

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APPENDIXES

	Page
National Science Foundation letter requesting suggestions from interested Government agencies	41
Appendix A—Replies from Government agencies:	
Department of Commerce	42
Department of Labor	43
Department of Defense	50
Civil Service Commission	52
National Aeronautics and Space Administration	54
Office of Civil and Defense Mobilization	59
Selective Service System	61
Department of Health, Education, and Welfare	62
Central Intelligence Agency	67
Appendix B—Listing of National Science Foundation publications on scientific manpower	69

National Science Foundation Letter Requesting Suggestions From Interested Government Agencies

The National Science Foundation consulted with other interested agencies of Government, and on October 5, 1959, sent the following letter to the Department of Commerce, the Department of Labor, the Department of Defense, the Department of Health, Education, and Welfare, the Civil Service Commission, the National Aeronautics and Space Administration, the Office of Civil and Defense Mobilization, the Selective Service System, and the Central Intelligence Agency:

"As the representative designated by your agency to work with the National Science Foundation in the preparation of the report on scientific manpower information for the House Committee on Science and Astronautics, may I invite your attention to some suggestions on procedure.

"You will note the House committee resolution requests a report by January 4, 1960, from the Foundation in consultation 'with other interested agencies of Government.' The report is to include 'summaries of the specific interests, needs, and recommendations of such agencies.' In order that the report may be prepared as expeditiously as possible, I suggest that your agency prepare an official statement to cover the following points raised by the committee:

"1. Your suggestions as to how the Foundation might secure appropriate information on both the formal training of scientific and technical personnel and their subsequent experience;

"2. The type and kind of information an effective register could most advantageously supply and should be expected to provide;

"3. In what manner and through what means such a record may best be maintained;

"4. Any other comment on these or related topics which seems pertinent to you.

Since time is short, I ask that your reply be forwarded to the Director of the National Science Foundation by October 30. You will have an opportunity to comment on the draft report which we hope to have by the end of November.

"You may find helpful some of the enclosed materials. They include a statement submitted to the House committee on July 2, 1959, describing the register operation, an extract from an earlier statement regarding the objectives of the scientific manpower program submitted to the committee on May 5, 1959, and a Foundation release on acceptance of responsibility for leadership in a program of national information on scientific and technical personnel. Needless to say, if there are other materials that the Foundation can provide, we shall be glad to supply them.

"Finally, I ask that you plan to attend a meeting in the auditorium of the Foundation, 1951 Constitution Avenue NW., on October 15 at 2 p.m. At that time, we would like to discuss with the agency representatives the general outline and con-

tent of the report, solicit suggestions, and agree on procedural matters. I regret that the preparation of the report will be on such a tight schedule, but see no alternative.

"The cooperation of your agency in the preparation of the report is greatly appreciated. If you find it impossible to attend the October 15 meeting, will you please call me on Code 178, Extension 372.

"Very truly yours,

"THOMAS J. MILLS,
"Program Director for Scientific Manpower."

APPENDIX A. REPLIES FROM GOVERNMENT AGENCIES

THE SECRETARY OF COMMERCE,
Washington, D.C., November 6, 1959.

DR. ALAN T. WATERMAN,
Director, National Science Foundation,
Washington, D.C.

DEAR DR. WATERMAN: The Department of Commerce is pleased to offer its comments and suggestions concerning studies of the scientific and technical personnel resources of the country for your use in responding to inquiries from the Committee on Science and Astronautics of the House of Representatives. Our interests, in this subject fall into two general categories.

As an employer of substantial numbers of scientists and engineers in such diversified fields as those covered by the Weather Bureau, the National Bureau of Standards, and the Coast and Geodetic Survey, the Department is concerned with all measures which may contribute to an improved supply and optimum use of such personnel. These interests are not confined to our own internal requirements however. The Department is well aware of the vital role of scientific and technical personnel in national defense and their rapidly increasing importance to the Nation's future industrial and economic development. For these reasons we heartily endorse the concept of a national program for the collection of information which will provide a better understanding of the size and characteristics of the Nation's scientific and technical community.

As the Federal Government's major factfinding and statistical service agency, our Bureau of the Census has collated, processed, and published a great variety of basic manpower data obtained in the decennial census of population, the monthly sample current population survey, and numerous other studies. It seems apparent that the special skills and facilities of this organization can provide important support for the proposed national program for the collection of statistical information on scientific and technical personnel. I am pleased to note that the National Science Foundation frequently has called upon the Census Bureau for consultation and assistance in this field, and I wish to assure you of our desire to continue this cooperation.

With regard to our suggestions for obtaining information on the training and experience of scientific and technical personnel, we believe that the recommendations in the Foundation's report "A Program for National Information on Scientific and Technical Personnel" are so comprehensive that our suggestions can serve merely to supplement rather than to add new items. One of the high-priority projects proposed therein offers, in our opinion, an effective means for obtaining important representative information concerning the training and experience of scientific and technical personnel in the United States. This project (designated as No. 3, p. 27), "1960 Census Survey of College Graduates, Scientific, Technical, and Other Specialized Personnel," would utilize the 1960 population census records as a base from which appropriate numbers of persons would be scientifically selected for further study by mail questionnaire. Among other important uses, the results of this survey would contribute to more effective understanding and utilization of data from professional society registers and similar less broadly based sources which are available or may become available during the next decade.

I understand that the Foundation has indicated its interest in this type of project through support of a small pilot study which is now in process. In view of the basic importance and central nature of the proposed project, it seems most appropriate that the Foundation should take the initiative in determining the kinds of substantive information needed so that cost estimates and operational procedures can be developed.

Regarding the National Register of Scientific and Technical Personnel, we see it serving two basic types of purposes: (1) To identify individuals with highly specialized skills in times of emergency, and (2) to provide statistical information concerning the scientific and technical community. We believe that much important and timely information concerning our manpower resources might be obtained through increased attention to the second purpose. For both uses, the more nearly complete the register is relative to the community it attempts to cover, the more effective tool it is. Moreover, for the statistical purpose, the register should be representative of the scientific and technical community, and it is important to know what portion of that community actually is covered. The above-mentioned 1960 census followup study would provide a measure against which register information could be evaluated, adjusted as necessary, and projected in later years.

We find it difficult to offer specific suggestions for improving the information content of the register or the manner in which it is maintained since we are not acquainted with specific experience in its utilization which would point out strengths and weaknesses. The general plan for voluntary registration in close cooperation with major professional societies seems well conceived.

In conclusion may I assure you that the Department of Commerce welcomes the leadership of the National Science Foundation in the proposed program for national information on scientific and technical personnel and wishes to cooperate in every way possible.

Sincerely yours,

PHILIP A. RAY,
Under Secretary of Commerce.

DEPARTMENT OF LABOR,
OFFICE OF THE ASSISTANT SECRETARY,
Washington, D.C., November 9, 1959.

MR. THOMAS J. MILLS,
Program Director for Scientific Manpower,
National Science Foundation,
Washington, D.C.

DEAR MR. MILLS: The Department of Labor welcomes the opportunity to comment on the questions raised by the House Committee on Science and Astronautics with regard to the current status of scientific manpower information and plans for future studies in this area. As you know, this Department has need for and makes extensive use of scientific manpower information in connection with a number of its major responsibilities. These include the following: (1) The development of programs and policies with respect to manpower in peacetime and under mobilization conditions; (2) publication of occupational outlook information for use in vocational guidance; (3) promotion of an effective nationwide system of public employment offices; (4) determination of education and training needs and development of skills of the Nation's work force; (5) promotion of employment opportunities for women; (6) providing industry and the public with essential facts on scientific and technical workers, as well as workers in other occupations.

To meet its program needs, the Department of Labor has been engaging in collecting and analyzing information on scientific and technical personnel since the 1930's. It is currently conducting a number of major studies in this area, including the development of estimates of current employment of scientists and engineers, the analysis of future personnel needs, and the collection of data on earnings of scientific and technical personnel. These and other programs conducted by the various Bureaus of the Department are discussed in the attached memorandum.

The following comments on the questions raised by the House committee reflect both our program needs and our experience in scientific manpower studies. They also take into account the report "A Program for National Information on Scientific and Technical Personnel" (hereafter referred to as the Hauser committee report) issued last year by your organization and the President's Committee on Scientists and Engineers. In our opinion, this report represents a comprehensive appraisal of the needs for scientific manpower information and should be given careful consideration in planning future studies in this area.

1. How to secure appropriate information on the formal training of scientific and technical personnel and their subsequent experience

A major part of the information needed on these subjects is already being obtained through the National Register of Scientific and Technical Personnel maintained by the National Science Foundation. The register provides much information on the education, professional characteristics, employment, and earnings of scientists who meet the qualifications for professional status established by the various scientific societies. Suggestions for strengthening the register are included under items 2 and 3 below.

In our judgment information obtained through a register of this type needs to be supplemented by at least two other kinds of surveys. First, followup studies of college graduates with undergraduate majors and postgraduate training in scientific and other fields should be made at intervals, in order to determine how many graduates obtain employment in their fields of training and what happens to those leaving these fields. These followup studies are also useful in providing information on graduates employed in scientific fields at levels below the minimums required for inclusion in the register. It is understood that the National Science Foundation is currently supporting a survey of 1958 graduates. The Department recommends that plans be made for further followup studies of these same graduates and also of future graduates.

In addition, in some of the most rapidly changing and critically important scientific fields there is need for more extensive information than can be obtained either from the register or from followup studies. It is therefore recommended that from time to time intensive analyses, in some cases through personal interview, be made of a sample of personnel in selected scientific and technical fields—to provide information on such questions as the educational requirements for these types of work, modifications needed in curriculums, and movement into and out of the given field.

2. Type and kind of information an effective register should be expected to provide

The Foundation's current register program already provides the major types of information which should be afforded by an effective register. This information includes data on the scientific specializations, training and experience, type of employer, geographic location, functions, and salaries of the personnel registered. Such data are extremely useful in the Department of Labor's occupational outlook program and other peacetime activities.

In addition, the Department, which has been designated as the principal civilian emergency manpower agency in a mobilization situation under World War II conditions or in a postattack situation, has studied the use of the register under these conditions. It is our conclusion that the register would have definite value in either situation. Under World War II type conditions, the register would be a most important tool for assuring the best utilization of our scientific and engineering talent. Under nuclear attack, we recognize that the resultant dispersal of people in many areas would make the use of the register more difficult. However, to the extent that any area escapes extreme dislocation of population, and with due consideration to availability of communications, the register would still be useful as a locator of needed scientific and technical skills.

3. Manner in which a register can best be maintained

In general, the Department of Labor considers that the plan followed by the National Science Foundation in maintaining its current register is an effective one. We strongly recommend that registration continue to be voluntary, since, in our judgment, compulsory registration would be neither feasible nor desirable. Even during World War II the National Roster of Scientific and Technical Personnel was maintained on a voluntary basis.

Furthermore, we recommend that the register continue to be compiled through the cooperation of the professional societies, since this method of operation is considered the most feasible. However, under this method of operation, it is probably impracticable to extend the coverage of the register to personnel who do not meet the established minimum qualifications for full professional status in a particular field. For this reason, we recommend that needed information on scientific personnel not meeting these qualifications be obtained through supplementary studies, as outlined under point 1 above.

Because of the Department's interest in the register as a defense readiness device, we further recommend that a duplicate file be maintained at the Department's relocation site as well as at the OCDM classified site. We also recommend that register print-outs be made available to the Department's Office of Manpower Administration's regional offices.

In view of the importance of up-to-date information on the employment and economic status of scientific and technical personnel, we strongly urge that additional resources be made available so that the National Science Foundation can rapidly process, analyze, and publish the information collected under the current register program. We also urge that this program and related scientific manpower studies be given as high priority as possible in the program of the National Science Foundation.

The engineering profession has so far been included in the register on only a very limited basis, through a so-called finder's list. It is our understanding that the Foundation has a study underway with regard to the feasibility and cost of establishing a comprehensive register of engineers. Pending the results of this study, no firm conclusions can be reached with regard to the desirability of such a project. The available information suggests, however, that the cost and administrative difficulties of registering so large a profession and of keeping the information up to date may be prohibitive. It appears that the needed information on engineers might be obtained more readily through the other types of studies suggested under item 1 above.

4. Other comments

We should like to emphasize that the register, although an important source of data, provides only part of the comprehensive information needed on scientific and technical personnel. As indicated in the Hauser committee report, there are other types of studies which should also be given high priority. Of these, the most fundamental are regular, periodic surveys of employment of scientific and technical personnel. Scientific personnel problems cannot be understood unless up-to-date information is available on the identification of scientists, engineers and technicians, how many there are, where they work, and what trends exist in their employment.

The Department's Bureau of Labor Statistics is already conducting some of these studies (described in the attached statement). In our judgment these studies should now be made a part of the Bureau of Labor Statistics regular program of collection and analysis of data on employment. It is our understanding that the National Science Foundation, which is currently sponsoring these studies, would like to see the responsibility for this program taken over by the Department of Labor.

We also recommend continuation of the intensive surveys of the characteristics, mobility, and economic status of members of different scientific and technical occupations, also called for by the Hauser Committee report. These studies would include information on all persons employed in an occupation regardless of level of training or experience. Thus, they would enable us to form a more comprehensive picture of manpower potential in a given occupation. A study of this type on the engineering profession for example, could provide us with vital information needed on persons without college degrees who are working in engineering jobs. Technically, these studies would be related to our surveys of employment, since they can be made within a subsample of the firms reporting employment of scientists, engineers and technicians. Occupational groups which should be surveyed as rapidly as possible include engineers, physicists, chemists, geologists, geophysicists, and many categories of biological scientists. It is proposed that intensive studies be made of two or three occupations each year. In our judgment, these studies should also be made part of the Department's program.

It is also recommended that the experimental studies of future demand for scientists, engineers and technicians described in the attached statement, be continued if they prove profitable. A series of coordinated studies of employment growth trends and other factors affecting demand for scientific and technical personnel designed to develop current estimates and forecasts of demand for such personnel was one of the projects listed as "most urgent" by the Hauser committee report.

The Department's Bureau of Employment Security and affiliated State agencies are already undertaking research into other areas of information on scientific and technical personnel not covered by the register, but considered important in the Hauser committee report. The research products of the employment security system are essentially geared to community manpower problems and the operation of local public employment offices. Studies include identification of such occupations; current and shortrun demand and supply analysis; development of aptitude tests for scientific and engineering fields; and manpower and skill requirements in specific labor market areas. More detailed information on these areas of research is found in the attachment to this letter.

Additional information on the characteristics, employment, and training of scientists, engineers and technicians is provided by studies conducted by the Department's Bureau of Apprenticeship and Training and the Women's Bureau. A brief description of the pertinent programs of these bureaus is included in the attached statement.

Very truly yours,

SEYMOUR L. WOLFBEIN,
Deputy Assistant Secretary of Labor.

DEPARTMENT OF LABOR PROGRAMS ON SCIENTIFIC AND TECHNICAL MANPOWER

A. BUREAU OF LABOR STATISTICS

The Bureau of Labor Statistics is one of the principal sources of basic statistical and analytical information in the manpower field. Statistics on labor force employment and unemployment are available each month and from time to time, employment projections, and other special studies are published. The BLS also conducts studies of employment of scientific and technical manpower in industry and other sectors of the economy. Many of these studies have been conducted under contract with the National Science Foundation and the results have been published by that agency. Major studies of this type are as follows:

"Science and Engineering in American Industry, Final Report on a 1953–54 Survey," National Science Foundation; 1956.

"Science and Engineering in Americam Industry, Final Report on a 1956–57 Survey," National Science Foundation (about to go to press).

1959 Survey on Employment of Scientific and Technical Personnel.—The results of a 1959 survey conducted for the National Science Foundation on employment of scientific and technical manpower in industry and other sectors of the economy are expected to be published in late 1959.

Survey of Scientific Research and Development by Nonprofit Organizations, 1959.—The compilation of data from a survey of research-development activities and employment of scientific and technical personnel in nonprofit organizations such as foundations, research institutes, museums, and health agencies has been completed. This survey was conducted for the National Science Foundation and the findings will be available from that agency.

Survey of Mathematicians, 1959.—A survey of nonteaching mathematicians employed in industry and Federal Government is currently in process (summer of 1959). This survey is being conducted in cooperation with the Mathematical Association of America with financing from the National Science Foundation. Results will be available in the fall of 1960.

Survey of Scientific and Technical Personnel in State Governments, 1959.—A pioneer survey to obtain information on the number of scientists, engineers, and technicians employed by State government agencies is currently underway (summer of 1959). Questionnaires will be mailed to approximately 3,000 State government agencies in the fall of 1959. Information will be obtained on the number of persons employed in the major scientific and engineering occupations and also on the chief activities of personnel engaged in these occupations.

Exploratory Study of Scientific and Technical Personnel Employed by Local Governments, 1959.—Plans are underway to study local government employment of scientific, engineering, and technical personnel in a few selected States. Questionnaires will be mailed in the fall of 1959.

Survey of Manpower Employed in Atomic Energy Activities.—The Bureau of Labor Statistics is planning a survey for the Atomic Energy Commission on employment in establishments engaged in atomic energy activities under contract with the AEC. This survey will provide an estimate of the total number of workers employed and the number of workers employed in selected engineering, scientific, technician, and skilled worker occupations in the atomic energy activities covered.

In addition to its statistical program the BLS makes analytical studies of employment trends and outlook in various industries and occupations. Some of these studies are in the form of technical reports on manpower; others are prepared and published as guidance literature.

Manpower Needs and Resources in the United States, 1957–75.—This BLS publication, now in preparation, will be a comprehensive report on manpower supply and requirements in the United States. The report will include trends and projections of the population and labor force. It will contain detailed analysis of past employment trends by industry and occupation (including scientific, engineering,

and other technical occupations). It will provide projections of employment by industry and occupation, and will assess the implications of these trends on educational and vocational training requirements.

Studies of demand for scientific and technical personnel.—The Bureau of Labor Statistics is beginning a study of long-range demand for engineering and scientific personnel. The project includes a pilot study which will attempt to develop (1) a systematic method for projecting demand for scientific and technical manpower in the United States and (2) a system for checking and improving such estimates at regular intervals. It is planned that a detailed study of long-range demand for scientific and technical personnel would be made in two major industries (chemicals and allied products and electrical equipment) based on comprehensive examination and analysis of existing trend data available in the BLS and on extensive interviews with officials in a large number of companies in these industries. In addition, long range projections of demand for scientific and technical personnel in the entire economy will be prepared, built up segment by segment on the basis of analysis of trend data for major industries available in BLS files. This study is being conducted under a contract with the National Science Foundation.

The Bureau of Labor Statistics is expanding its program of community wage surveys of white-collar pay in private industry. Eighty metropolitan areas will be covered; professional and managerial pay including salaries in engineering and physical sciences, and mathematics will be covered on a nationwide basis. The first report is due in December 1960.

The purpose of the study is to obtain comparative information for related Federal Government grades. The survey will cover 28 occupations, including engineering, physical sciences, mathematics and others. It is planned to cover 2,100 establishments from manufacturing, transportation, communication, public utilities, trade, finance and insurance, and engineering and architectural services.

The major BLS publication in the guidance field is the Occupational Outlook Handbook. This publication is revised periodically. The latest edition will be published in the fall of 1959. It provides up-to-date information on the employment outlook, nature of the work, entrance requirements, training needed, and earnings in approximately 600 occupations and 30 major industries. Included are chapters on scientific and related fields of work, such as atomic energy field; biological sciences; electronics; engineering; health services; physical and earth sciences; statistics and mathematics; and technician occupations. Individual reprints of most of these chapters will also be published.

The BLS also publishes a magazine, Occupational Outlook Quarterly. This publication summarizes the results of the BLS research program in the occupational outlook field, including work in the scientific manpower area, and relevant studies and activities conducted elsewhere in the U.S. Department of Labor, other Government agencies, and private organizations.

Other recent guidance pamphlets prepared by the BLS which may be of interest to persons in the scientific manpower field are:

"Employment Outlook for Technicians, a report on Technicians Who Work With Engineers and Physical Scientists"—Veterans' Administration, Department of Veterans' Benefits in cooperation with the U.S. Department of Labor, Bureau of Labor Statistics, VA pamphlet 22–1, March 1958.

"Mathematics and Your Career"—free. U.S. Department of Labor, Bureau of Labor Statistics, Washington, D.C., 12 pages illustrated.

B. BUREAU OF EMPLOYMENT SECURITY

1. Identification and definition of scientific and technical occupations

The Dictionary of Occupational Titles is presently undergoing a comprehensive revision. The present coverage is being analyzed to reflect the current occupational picture in the economy. Special efforts are being made to present up-to-date data for scientific and professional activities, especially in those industries and new technologies emergent since World War II such as peaceful uses of atomic energy, rocketry, guided missiles and electronics.

At the request of the President's Committee on Scientists and Engineers and the NSF, the BES is engaged in a study to identify and describe technician jobs that may be considered supporting to engineers and physical scientists. The NSF supported this study for 1 year and the study has continued since the expiration of those funds with the needed financing being supplied by the BES.

More than 600 job analyses were made of technicians' activities, primarily in aircraft and automobile manufacturing, roadbuilding, and electrical and elec-

tronic equipment manufacturing. This material has provided the basis for developing several releases on over 130 jobs, presenting prevalent job titles, descriptions of the work performed by the technicians, industries in which the jobs are to be found, education and training required by employers, physical demands of the jobs, and working conditions. They also will include special worker characteristics considered desirable for successful job performance such as special vocational preparation, aptitudes, interests, and temperaments. Job definitions resulting from this material will be included in future releases of the Dictionary of Occupational Titles.

2. Current labor market conditions in engineering, scientific, and technical occupations

This bimonthly report was initiated at the request of the National Science Foundation and the President's Committee on Scientists and Engineers. The report is based primarily on special analyses of current conditions in the 30 largest major labor market areas and on statewide statistics on job openings for these occupations which have been placed in interarea clearance by public employment offices. Information is also being developed from other sources, such as departments of the Federal Government, university placement services, professional societies, etc. The National Science Foundation is currently supporting this activity.

This report should be expanded to cover additional occupations, especially other groups of scientists and supporting technicians found to be in short supply nationally. This analysis should also be expanded to provide information on a greater number of labor market areas. Many important research centers and universities are not now covered by the current list of the 30 largest areas.

3. Scientific and engineering occupational characteristics for selected industries

A pilot industry-occupation manpower study covering the chemical industry was conducted in 1957 at the request of the National Science Foundation and the President's Committee on Scientists and Engineers. For each of the selected occupations, information on employment trends, job vacancies, and requirements during the next year were analyzed, together with the problems of labor demand and supply, turnover, utilization, and hiring practices. This information was obtained by local offices of the State employment security agencies.

Following the pattern established in the study covering the chemical industry and utilizing techniques developed for area skill surveys, further industry studies might be prepared covering those other industries in which the employment of scientists and engineers is considered significant.

Detailed current information as to the character of engineering and scientific occupational shortages and requirements is needed to keep Government agencies, industry and the public informed of the nature of manpower problems in this key occupational area. This information would also be of considerable value for improving local employment services in employer relationships, in developing recruitment programs, in stimulating community interest in the effective development and utilization of these skills, in counseling and in other services to applicants. Data to be collected through the local employment offices, would provide information on an industrywide basis for selected engineering and scientific occupations, composition patterns, employment trends, current shortages and future requirements. In addition, information would be obtained from each establishment regarding its recruitment practices and problems involving labor turnover and personnel utilization.

4. Research into aptitudes in science and engineering

The Bureau of Employment Security is conducting research for the development of aptitude test batteries for engineering and scientific fields and for supporting technical occupations. This Bureau is also conducting research for development of aptitude test norms for use with 9th and 10th grade students in order to provide early identification of youth with talents for these occupations and other occupations.

5. Job opportunities information studies

In addition to the above studies which are conducted by BES at the national office level, some 45 State employment security agencies, with the technical assistance of this Bureau, are engaged in a program of collecting, analyzing and publishing State and local job opportunities information. Area skill surveys providing the occupational composition of current employment, anticipated require-

ments, labor supply and related data are completed or in progress in 34 States. These surveys, requiring analyses of current and anticipated employment opportunities and manpower resources, usually include studies of demand and supply of scientific and technical occupations. In some instances, State agencies have conducted studies specifically on these occupations; other studies have covered all occupations and several have been limited to jobs in skilled occupations. In most instances, the consideration of the demand and supply in selected occupations has included an evaluation of the output rate of area training facilities, including colleges and technical institutes, as well as apprenticeship and other in-plant programs.

Area skill surveys are particularly useful to a community in providing a factual base for redirection of local educational and training objectives covering technical manpower. Such surveys can pinpoint detailed occupational needs not translatable from nationwide estimates in broad occupational categories.

In addition, 31 State employment security agencies are preparing guides for separate occupations or occupational fields. These guides contain basic information on the job content and economic factors associated with the occupation. Many guides have been prepared on engineering, scientific and technical occupations.

If additional funds were made available, the Bureau of Employment Security and affiliated State agencies would be in a position to undertake a needed expansion of this program. Area skill surveys should be conducted in many more areas, to provide the factual data necessary for local action programs geared to improve the skills of the work force. Occupational guides should be prepared in more occupations, especially those in scientific and technical fields.

The program of area skill surveys has heretofore been geared almost entirely to local community needs. However, the problem of nationwide shortages of certain types of scientific and technical personnel is perforce the problem of many areas. The BES should encourage a large number of areas to conduct skill surveys at relatively the same point of time, with an occupational coverage of the same basic core of selected occupations for the collection of data in depth. This would provide an insight into manpower needs in significant occupations on a basis suited for national considerations, as well as for local action programs.

C. BUREAU OF APPRENTICESHIP AND TRAINING

The Bureau of Apprenticeship and Training works with employer associations, labor organizations and other groups at both the national and the local level to provide a favorable climate for training. As part of its program, this Bureau recently completed a pilot study of industrial training in Trenton, N.J. The results of this study were published by this Bureau in the report, "A Look at Industrial Training in Mercer County, New Jersey." The purpose of this survey was to develop and test procedures to be used by the BAT in a nationwide study of training in industry. Information was obtained on technical, management, apprenticeship, and other types of training programs.

The BAT also conducts research studies to obtain information that will assist labor and management organizations in appraising training requirements. Several pilot projects in a number of industries were underway in fiscal 1959 aimed at encouraging craftsmen and technicians to continue their training.

D. WOMEN'S BUREAU

The Women's Bureau has recently completed and sent to the printer the results of its research on employment opportunities for women in the physical sciences. A preliminary report entitled "Careers for Women in Science" was published in the Occupational Outlook Quarterly of September 1958, and reprints of this article were made available for distribution. The final bulletin entitled "Careers for Women in the Physical Sciences" and a companion leaflet, "Science Futures for Girls," will be available for distribution later this year.

Research is currently underway for similar reports in the biological sciences, including biologists and biological technicians. This study will be completed some time during the current fiscal year.

The objective of these projects is to provide more information about careers for women in these fields in order to encourage a great number of young women to consider the possibility of pursuing a career in the sciences.

ASSISTANT SECRETARY OF DEFENSE,
MANPOWER, PERSONNEL AND RESERVE,
Washington, D.C., November 4, 1959.

Dr. ALAN T. WATERMAN,
Director, National Science Foundation.

DEAR DR. WATERMAN: In response to your letter of September 23, we indicated that the Department of Defense would cooperate in the fullest degree in the preparation of the report requested by resolution of the House Committee on Science and Astronautics. Subsequently, members of this office met with staff of the NSF and other interested agencies to develop plans for the report. It was agreed that each agency would comment on four specific points.

Before proceeding with our comments on those points, we desire to go on record in favor of the continuation of the National Register of Scientific and Technical Personnel. In our opinion, it is a valuable tool for peacetime and wartime use. The comments which follow will serve to demonstrate the importance we attach to the register.

1. Suggestions as to how the Foundation might secure appropriate information on both the formal training of scientific and technical personnel and their subsequent experience

We believe that the present basic method of obtaining such information directly from individuals, through the professional scientific and engineering societies and under the direction and coordination of the NSF, should be continued. It is our opinion that all registration during peacetime should be on a voluntary basis.

It is noted that estimates of present coverage among scientific disciplines range from 50 to 90 percent, and that total coverage amounts to about 170,000 of an estimated 250,000 who are qualified to be included in the register. We believe that the present qualification criteria for inclusion, Ph. D. degree or equivalent education and experience, should be continued. As a possible means of increasing the coverage of qualified individuals, which we feel is desirable and necessary, consideration might be given to circularizing those who have not cooperated thus far with a special letter signed by the President's Special Assistant for Science and Technology, or similar top official of the executive branch, attesting to the importance of the register to the Nation and urging cooperation.

Consideration might also be given to supplementing the basic collection of data through the professional societies with secondary sources. Some of these secondary sources, such as the Roster of Scientists and Engineers in the Federal Service, could probably be adapted for use by the National Science Foundation thereby eliminating duplication of effort.

It might also be worthwhile to consider enlisting the aid of the larger employers of such personnel in urging those of their employees who meet the qualification standards to register. Employer cooperation would largely depend, of course, on a continuation of the present policy of not using the register as a peacetime placement device—a policy which is necessary in the present circumstances.

The present register covers the natural sciences and certain related disciplines such as geography and demography. The Department of Defense recommends that the coverage of the register be expanded to include area-language specialists. Persons possessing such capabilities with respect to many of the lesser known but highly important nations of the world are relatively rare, and information on them is not readily available.

The present coverage among engineers is, we understand, limited to a "finders list" of about 20,000 persons. This list is designed to serve the emergency location function primarily. While our initial reaction is that the register should be expanded to assure more adequate coverage of top-level engineers working on applications, in the newer fields—such as electronics, nucleonics, and astronautics—we should like to have the benefit of the special study being made by the engineers joint council before formulating any positive recommendations.

In summary, it is our recommendation that the present system used in obtaining information on the formal training of scientific and technical personnel and their subsequent experience be continued. We further recommend that the coverage of natural scientists within the current criteria be expanded, and that a register of area-language specialists be established.

2. The type and kind of information an effective register could most advantageously supply and should be expected to provide

We believe the register should supply information to meet two main purposes which we consider the principal justifications for the register. In peacetime, the

register should provide statistical information which will facilitate the evaluation of numbers, quality and trends of U.S. resources in specialized scientific and engineering fields. This information could be used, when measured against demand, to determine where increasing emphasis should be placed in our educational system. It could also be used as a basis for Federal Government policy on education and research. The aforementioned uses are only broadly illustrative.

The second basic purpose of the register should be to improve preparedness for a possible mobilization. In an emergency it is expected that certain manpower controls will be instituted and it will be necessary to shift workers from less essential to more essential activities. It will be extremely important to be able to identify and locate persons with particular specialized skills quickly. Compilation of the register in peacetime will greatly facilitate the accomplishment of this objective. In addition, establishment of a register for certain professions in peacetime will provide the procedures, techniques and experience for possible elaboration or further registration in wartime should special needs arise.

The information called for in the current questionnaires will, in our opinion, generally, be adequate to meet the two basic objectives described above. We refer to items related to certain personal characteristics; address; higher educational background; present employer, employer activity, employee functions, job title and salary; areas of specialization and experience; and foreign language competence and other specialized knowledge of foreign countries. We believe addition of other items should be avoided unless it can be shown that they will greatly enhance the value of the register, since maximum cooperation of individuals will depend to a large extent on the size of the questionnaire.

3. In what manner and through what means such a record may best be maintained

We understand that the register is in general not current either with respect to substantive information on education and work experience or addresses of the registrants. This greatly reduces its value both for peacetime purposes and for mobilization readiness. We realize that the professional socieities have more up-to-date information on current addresses of their members. We believe, however, that the Government should maintain reasonably current address information on all registrants in order to meet the objectives of the register. It is recommended that consideration be given to developing a program, using the present cooperative arrangements with the professional societies, for updating information on education and work experience at least biannually and for obtaining current address information at least annually.

In our opinion, this program would provide adequate information for use of the register in the initial phase of any emergency short of nuclear attack on this country. As a method for coping with the latter eventuality, it is suggested that consideration be given to a plan under which registrants would mail a card to the NSF as soon after the attack as possible, showing their address at that time. Arrangements might be made with the post office to provide necessary preaddressed mailing cards to the registrants in a manner similar to the procedure devised by the Civil Service Commission for Federal employees. An alternative to this procedure would be to request registrants to report to the nearest local public employment office, which would in turn inform NSF.

It is further recommended that consideration be given to decentralizing the register for mobilization readiness purposes. Microfilm copies might be placed in each of the Office of Civil and Defense Mobilization regional headquarters cities to expedite the use of the register by potential employers and emergency manpower agencies during a mobilization. This would be especially important in the event of attack on this country.

4. Any other comment on these or related topics which seems pertinent

While all of the foregoing comments have been directed toward the register of scientific and technical personnel, we fully realize that the register can be but one important component of a broader scientific manpower information program. Other types of inquiries and studies must be undertaken if we are to have adequate information on this Nation's resources, requirements, utilization, training and other aspects of our scientific manpower. We are gratified to note that the Foundation has assumed the primary responsibility in this entire field and has initiated a rather comprehensive program of scientific manpower information based on the recommendations of the Advisory Panel on Scientific Manpower Data Requirements and various Federal agencies, including this Department. We urge that maximum practical efforts be expended in carrying out the program.

Sincerely yours,

CHARLES C. FINUCANE.

U.S. CIVIL SERVICE COMMISSION,
Washington, D.C., November 16, 1959.

Hon. ALAN T. WATERMAN,
Director, National Science Foundation,
Washington, D.C.

DEAR DR. WATERMAN: As requested in your letter of September 23, 1959, and in Mr. Mills' letter of October 5, 1959, we have prepared the following statement to cover the points raised by the House Committee on Science and Astronautics.

1. Suggestions as to how the Foundation might secure appropriate information on both the formal training of scientific and technical personnel and their subsequent experience

In this regard, we have reviewed the recommended program of the Advisory Panel chaired by Philip M. Hauser of the University of Chicago.

In recommending a program of 15 separate projects to provide necessary information relating to scientific and technical manpower, the Advisory Panel has recognized that the maintenance of a national register of scientists alone is not sufficient. We are in general agreement with the Hauser report recommendations. Adoption of the recommendations, coupled with timely analysis and dissemination of the information, should provide a comprehensive picture on the supply, demand, and utilization of engineers and scientists, whether employed in industry, Government, or educational institutions.

The Hauser report recommendations provide a good framework for any suggested program for securing necessary information for a national register and for obtaining current data on both long- and short-range estimates of needs for engineers and scientists.

Page 26 of the Hauser report states that periodic surveys of employers should be made, and that such surveys of Federal agencies might be through a central unit of control, such as the Civil Service Commission.

In this regard, the recommendations of the information essentials group are of interest. The information essentials group was an interagency committee brought together at the direction of Mr. Rocco C. Siciliano, the Special Assistant to the President for Personnel Management. This group was asked to determine (1) what statistical data were needed on Federal scientists and engineers by management in employing and central staff agencies; (2) how often the data should be gathered; and (3) in what detail. The information essentials group made the following major recommendations in a report which was submitted to Mr. Siciliano on June 4, 1959:

1. A uniform Governmentwide reporting system for gathering statistical information on Federal employees in engineering and scientific occupations should be established.

2. The reporting system should include:

(*a*) An annual inventory of current employment which would be part of the Commission's survey of white-collar occupations, with additional data on function, age, and sex of scientists and engineers.

(*b*) A semiannual report of employment data on accessions from outside the Federal service (e.g. industry, school) and from within the Federal service (transfers); separations by type and destination (e.g. voluntary quits and transfers); current vacancies; and promotions.

3. The Commission should be designated as the agency to administer the proposed Government-wide reporting system.

4. The Commission should be requested to conduct the survey of white-collar occupations annually and sufficient funds should be provided to permit analysis and publication of results reasonably soon after a survey is completed.

In the event the recommendations of the information essentials group are adopted, the Commission will be happy to furnish all available information on Federal scientists and engineers to the National Science Foundation. This would include summary data on numbers, occupation, compensation, and other economic and personal characteristics of these Federal scientific and technical personnel.

The Commission now maintains a Federal Roster of Scientists and Engineers. It is confined to the approximately 21,000 scientists and engineers at GS–13 and higher levels employed by the Federal Government. This roster is fully described on pages 812 through 833 of the printed hearings before the House Committee on Science and Astronautics held on June 24 and 25, 1959. If this Federal roster were to be extended downward, with the same position coverage, an approximately 84,000 additional Federal scientists and engineers would be added to the roster.

Depending upon the desires of the National Science Foundation, the information from our Federal roster can be incorporated into the national register. Or, if

preferable, and if it is decided that the Federal roster should be extended downward to cover the approximately 105,000 scientists and engineers in the Federal service, the Federal roster can be considered as a portion of the national register, even though it remains physically located in the Civil Service Commission, and is maintained by the Commission.

The Civil Service Commission has been working very closely with the Federal agencies in the development of plans for emergency mobilization. Agencies are developing emergency staffing patterns for this purpose. Concurrently, they are developing lists of available personnel which would result from temporarily discontinued functions due to the emergency. If desired, and when available, this data can be furnished to National Science Foundation as Federal Government supply and demand data for this very specialized purpose.

2. The type and kind of information an effective register could most advantageously supply and should be expected to provide

Our response to this question is confined to the relationship between the national register and the Federal Government as an employer. The Commission feels that such a register should be as complete as possible, and should include all professional engineers and scientists, including social scientists. The register should include sufficient information, including age, sex, education, specialization, employment, and location, about the registrants for emergency mobilization purposes as well as for statistical information purposes. Information regarding employment on the national register should contain adequate information so that those registrants working in nonessential employment to be curtailed in the emergency may be readily identified and made available to essential employment, as defined by Office of Civil and Defense Mobilization.

Periodic updating, at least annually, of the register by questionnaires is essential to keep records reasonably current and usable.

The key to a successful register is timeliness. Data on salary levels of 3 or 4 years ago are of little value to the Commission in making review of the Government's salary schedules. Data collected should be analyzed and the information disseminated within the year.

The Commission believes that the national register should be able to furnish summary data on such information as:

(1) rates of turnover, by specialization, in industry, Government, and educational institutions;

(2) salary levels, by specialization, in industry, Government, and educational institutions;

(3) geographical distribution, by specialization, in industry, Government, and educational institutions;

(4) educational levels, by specialization, in industry, Government, and educational institutions;

These types of data would be very helpful to the Commission, in its role as the central personnel agency for the Federal Government, in reviewing current policies for recruitment, placement, and utilization of engineers and scientists in the Federal Government and in developing changes in these policies. The data on salary levels would be helpful in connection with periodic reviews of the Government's salary schedules.

3. In what manner and through what means such a record may best be maintained

Since such a national register should be as complete as possible in its coverage of eligible scientists and engineers, but at the same time should be established on a voluntary basis, the Commission feels there should be a concerted and continuing effort to publicize the national register, describing its purposes and asking for the cooperation of individual scientists and engineers. The better known the register is, the higher the response rate to its questionnaire will be. Whenever the register is updated through individual questionnaries to the registrants, response may be enhanced by sending along summaries of data analyzed in the previous year.

Consideration should be given to the feasibility of establishing duplicate sets of records from the national register for use by the Federal manpower agencies in a national emergency. These duplicate sets could be maintained at the regional emergency relocation sites of such agencies as Department of Labor, Civil Service Commission, and Office of Civil and Defense Mobilization. Records at these regional sites could be confined to persons residing in the regional area. In addition, again for purposes of national emergency planning, consideration should be given to furnishing those Federal agencies with important emergency roles information on persons on the national register with skills crucial to the emergency func-

tion of the agency. For example, lists of construction engineers could be furnished to the Housing Agency, and lists of sanitary engineers and chemists could be furnished to Department of Health, Education, and Welfare.

4. Any other comment on these or related topics which seem pertinent

As indicated earlier, a national register is merely one segment of the overall picture on scientific manpower information. The register furnishes data on supply; data on demand must be obtained from other sources. The Commission has recognized that estimates of long-range manpower requirements of the Federal Government are needed. The Commission has taken the first step toward forecasting Governmentwide manpower requirements. On a pilot-study basis, the Commission asked 10 agencies to estimate, as of December 1958, their scientist, engineer and certain other manpower requirements over a 1-year and 5-year period. Results of this survey are now being evaluated. If the initial forecast based on the pilot study is considered valid, a regular long-range forecast of manpower requirements may be included as part of the Commission's regular statistical reporting system.

We understand that apart from the above statement, Mr. Mills wished to obtain the approximate cost figure for our Federal Roster of Scientists and Engineers. The initial establishment of this roster involved an expenditure of about $20,000.

Our ability and willingness to develop and to furnish to you the manpower information described above depends, of course, upon reaching a mutual understanding relating to the public dissemination of information on Federal scientists and engineers and on the availability of manpower and funds.

Sincerely yours,

ROGER W. JONES, *Chairman.*

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION,
Washington, D.C., December 18, 1959.

DR. ALAN T. WATERMAN,
Director, National Science Foundation,
Washington, D.C.

DEAR DR. WATERMAN: This agency has given considerable thought to the request in your letter of September 23, 1959, and in the more detailed letter of October 5, sent by Mr. Thomas J. Mills.

Attached is the NASA position concerning its specific interests, needs, and recommendations in this matter, entitled "Statement of the National Aeronautics and Space Administration Concerning the National Register of Scientific and Technical Personnel."

Sincerely yours,

HUGH L. DRYDEN, *Deputy Administrator.*

STATEMENT OF THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION CONCERNING THE NATIONAL REGISTER OF SCIENTIFIC AND TECHNICAL PERSONNEL

The National Aeronautics and Space Administration submits to the National Science Foundation the following comments in response to the Foundation's request for an official statement of NASA's interests, needs, and recommendations concerning scientific manpower information. These comments cover each of the points raised in Mr. Mills' letter of October 5 but are organized in a somewhat different manner.

Interest of NASA in manpower information

The National Aeronautics and Space Administration has a strong interest in and need for manpower information to serve as the basis for planning and action, both short range and long range. This need is not now being adequately met.

NASA's need is particularly urgent because it is a growing agency, its work involves new skills and knowledges in scarce supply, and its acti ities involve or affect not only its own staff but also a broad range of the Nation's industrial and academic manpower.

NASA's mission does or will involve virtually the entire spectrum of fields of research, development, and other technical work. Thus NASA needs information concerning a broad range of science and technology, including the physical sciences, engineering, biological sciences, behavioral and social sciences, and related fields. It also needs information, in grosser terms, concerning nontechnical areas as a basis for comparisons, since the Nation's culture and economy should not become distorted or unbalanced.

With respect to level of coverage, NASA's concern extends from the highest levels of prominent scientists down through those having just achieved the bachelor's degree or equivalent. NASA also needs information concerning young men and women now enrolled in colleges and universities and grosser data concerning secondary school enrollments and trends. In addition, NASA needs information not now available concerning highly skilled subprofessionals and technicians in a wide variety of fields, and trends concerning the supply of and demand for them.

The uses of such information are widely varied. Included are the use of manpower information to serve as the basis for (1) planning recruitment and staffing programs; (2) justifying or supporting budget requests for new or expanded programs in terms of availability of skilled manpower; (3) development of qualification and examination requirements in terms of interrelationships and overlap of fields and disciplines, based on factual data concerning actual backgrounds of specialists now working in specific fields; (4) recommendations concerning salary levels; (5) recruitment and utilization of women scientists and technologists; (6) development of training programs in shortage categories; (7) advice to colleges and universities concerning need for curriculum changes in the space sciences and technologies; (8) age distributions by specialty to provide a basis for both internal and external educational and related adjustments; (9) geographical distributions and trends for recruiting and other purposes; (10) distributions and trends with respect to proportions of research, development, design, production, teaching, and other functions; and a variety of other aspects and uses.

All of the preceding is with reference to numerical and statistical information and interrelationships of such data. In addition, NASA would find valuable uses for lists of names and addresses of certain types of specialized scientists and engineers, or up-to-date directories of specialists. The intention would not be to use these as a placement service, since this can more properly be done through the professional societies or by other means, and since such lists or directories would not include enough data for placement use. But such directories or specialized mailing lists could be put to good use by NASA in such ways as the following: (1) Sending notices of availability of new technical reports or translations in the space and aeronautical sciences direct to those working or qualified in the specialties concerned; (2) obtaining help in forming advisory committees and employing consultants; (3) direct-mail notices of technical meetings and conferences; (4) direct-mail notices of specialized recruiting needs; and (5) facilitation of intercommunication among specialists in the same fields, thus enriching the cross-fertilization of ideas.

Importance of the register

The major characteristic of the register is that all of its information has the individual as the unit, with the millions of bits of information tied together in packages representing separate persons. Stemming from this characteristic is the flexibility of the register system which allows the user (*a*) to start with a pattern of characteristics and select an individual or group of individuals, or (*b*) to analyze the information statistically while ignoring individual identity entirely, or (*c*) to start with the name of an individual and determine his characteristics.

It seems to NASA that these functions of selection, analysis, and reference can all be efficiently performed by a register. While the reference function is also performed by published biographical directories, which include more personalized detail than register data, such directories are inherently out of date in much of their information due to publication lag and separation between successive editions while alphabetical register machine-listings can be current within a few months.

The register should also be compared with tabular information obtained through surveys of employers of scientific and technical personnel. Such tabular information cannot be broken down finer than the lines and columns provided to the employer. Thus the entries in each cell, defined by a line and a column, hide a variety of types of information. For example, if tabular information is requested by age and sex, and separately in another table by specialty and level of academic degree, additional tables are required to relate age and specialty, age and degree, sex and specialty, sex and degree. Such multiplication of tables is naturally resisted by those providing the information, and avoided by those requesting it. But all of these two-factor tabulations can be readily obtained when the individual is the unit of information, and numerous additional ones as well. In addition, three-factor, four-factor, and higher subdivisions can easily be made. One example, actually performed from register data, involved obtaining the distribu-

tion of salaries (number of individuals at each of 12 salary levels) for physiologists, male, engaged in research, in universities, who have a doctor's degree, and who have between 2 and 4 years of professional experience. Such a breakdown would hardly be feasible using the tabular approach.

Furthermore, if information concerning knowledges and skills is required, the individual himself should be contacted as the source. Information requested from employees, whether in terms of the tabular approach or with a separate questionnaire or card for each individual, cannot reliably obtain information going beyond what the individuals are currently working on and some information about past work experience and education—and even this is costly for employers to produce because of the way in which titles are used and personnel information is maintained. But the register questionnaire goes directly to the individual, the one person most knowledgeable about his qualifications and his work.

On the negative side of the situation the register, if registration is voluntary, cannot include precisely all scientific and technical personnel, at least without prohibitive cost in obtaining information from the last few individuals. Hence it cannot and should not be used as the definitive source of total numbers of scientific and technical personnel. Such data, which in the last analysis are estimates or approximations, need to be obtained by supplementary surveys of other types, including detailed sample surveys of Bureau of the Census type involving door-to-door visits, and other approaches. Such techniques would provide correction factors concerning percentage of register coverage, which probably vary from field to field and from one type of employer to another.

It also seems to NASA that the register cannot supply information concerning demand, or supply-demand relationships.

But the register can provide a wealth of valuable information if it can approach a 90 or perhaps even 95 percent response rate. This is probably attainable if voluntary registration is made worthwhile to the individual scientist or engineer. The key to this level of success is a combination of multiple motivations and services, instead of the early register use of the single motivation of patriotism and the providing of little or no service, to individual respondents. Multiple services in themselves would provide multiple motivation: (*a*) Sending first to the registrant reports giving salary and other information concerning his own field; (*b*) inclusion (unless he objects) in special mailings of interest to him; (*c*) inclusion (unless he objects) in published directories of specialists; (*d*) use of information about him (if he requests) in the placement-service operations of professional societies; (*e*) demonstrating that the register goes to the trouble of not asking him again for information he has already furnished, and is concerned about the time he spends in preparing and submitting the information about himself; (*f*) providing, perhaps, a wallet-size register identification card bearing his register serial number; (*g*) and in other ways generating the realization that his Nation is concerned about him as a rather special individual. With coverage at a high percentage level, and maintained on a current basis, the register would be able to provide unparalleled service to the Nation in a wide variety of ways

On the basis of these and other considerations, NASA recommends that the register be used as the key information-collection and data-producing agency of the Foundation's manpower studies function, supported and supplemented by other types of approach as needed.

Need for a single, centrally maintained register

NASA recommends that there be a single National Register of Scientific and Technical Personnel, and that it be maintained centrally, as provided in the National Science Foundation Act of 1950. This means, in the opinion of NASA, that any separate registering operations such as that of the Civil Service Commission, should be performed by or under the Foundation's register, closely coordinated with the register's other information-collection work, and that the collected data may thereafter be furnished for such special uses as placement within the Federal Government.

In addition, the register should explore more fully the matter of approaching large employers, industrial and academic as well as governmental, on behalf of obtaining information direct from their employees. The coordination of such approaches with the activities of the cooperating professional societies may present administrative difficulties, particularly in the fields of engineering.

Register coverage

As indicated in the first section of this report, NASA has need for detailed current information concerning all levels of scientific and technical personnel, even down into the student category, covering all fields of science and technology. NASA believes that other organizations have a comparable need.

Hence, NASA recommends specifically that (1) register coverage begin at the college senior level, in the manner now conducted by the National Research Council to register 100 percent of all doctorates before they receive their degrees; (2) that registration efforts be broadened to cover all fields of science and engineering; (3) that contacts through employers and other sources, including attendance at technical meetings and checking of technical publications and news notes, be intensified so as to register individuals who are beyond college or who did not complete college but are nevertheless professionals in their fields; and (4) that serious consideration be given to extending register coverage to technicians in certain subprofessional or allied areas that are intimately interrelated to and supportive of scientific and technical work and are in short national supply, this extension to include registration of graduates of 2-year or 3-year technical schools. Supplemental and associated manpower studies should accompany the activity of the register in this broadened, deepened, and intensified approach.

Improved classification system

It seems clear that manpower information, in order to be useful statistically or for identifying individuals through sorting processes, must be in the form of classes or categories. Uniform terminology must be used, even though it may do some violence to reality in such rapidly changing fields as science and technology, and even though individuals and their work and qualifications are infinitely more complex than any classification system can provide for. Herein lies one of the major problems of the register and all other activities concerned with manpower information.

The present register classification of scientific and technical specialities is to a considerable extent obsolete and otherwise unsatisfactory, and is known to be so recognized by the Foundation. As a result, studies to improve it are already underway. NASA recommends that a major effort be made by the Foundation to devise a new and much improved classification system having the following characteristics: (*a*) Coverage of all of science and technology, since scientists and engineers are known to have secondary competencies in scattered and unexpected directions, since the need for register information in specific areas cannot be predicted, and since the various aspects of science and technology are interrelated in complex ways; (*b*) flexibility and expansibility to accommodate future growth in unexpected directions; (*c*) construction in block or hierarchical form to allow different levels of fineness of treatment, partly to provide for generalists as well as specialists, and partly to allow gross as well as fine statistical analyses; (*d*) provision for various present and future hybrid fields; (*e*) provision for a variety of technical applications; (*f*) condensation into reasonable length, since under a voluntary registration system the amount of checklist material sent to a respondent should not impose an undue burden; (*g*) compatibility with existing and past statistical series, insofar as possible, so as to allow studies of historical trends; and (*h*) suitability for machine handling.

This is a large order and of basic importance. Not only do successful efforts of the register depend upon development of such a multipurpose flexible system, but also other manpower studies including those of other Federal and non-Federal agencies, and related activities including classification of scientific and technical documents, since all are interrelated aspects of the world's work in science and technology.

Hence, NASA recommends that the necessary information be gleaned where the scientific and technological work is actually done, at the grassroots among scientists and engineers engaged in their work, and that maintenance and updating of the system be conducted in like manner, with centralized analysis of the gathered information. This will require a skilled staff for the one objective, who should use feedback continually from many sources including data from register analyses and means of contact with individual respondents concerning failures of the existing system to provide for their individual types of work.

Speed of processing and use of modern EDP technology

NASA is in agreement with the Foundation's movement toward utilizing the most modern electronic data processing technology in the maintenance and analysis of register and other manpower data. This may involve the use of magnetic tape or other memory devices in addition to or in place of punched cards, depending upon the findings of investigation. The objective is to achieve maximum flexibility and speed of operation, combined with maximum savings in the use of clerical manpower.

Use of modern EDP technology can help provide what should be a major objective of the manpower studies function—production of regular and special

reports within as short a period as a month of collection or updating of the information, instead of 3 to 5 years. Such speed in processing would add greatly to the value of statistical and other reports. It is known that the Foundation is already moving in this direction.

Maintaining currency of information

One major aspect of register operations is the maintenance of current addresses, since mailing addresses of scientists change on the average about 30 percent a year. The objective should be to maintain addresses current within about a 6-month range.

The development and maintenance of a system for updating substantive information is more of a problem. It is suggested that such updating be on the basis of three categories. Category I would include personal and historical information such as name, date of birth, sex, citizenship, and educational history, which normally does not change and should only be checked periodically for accuracy. Category II would include basic qualifications information, which could be updated every 2 to 3 years. Category III would be limited to employment information, including salary, type of employer, etc., which changes rapidly and should be updated at intervals of 6 months to a year, using a condensed checklist questionnaire or card, perhaps of the mark-sensing type for machine handling.

Level of financial support

NASA cannot properly recommend any specific level of financial support for the register and manpower studies.

But NASA considers that the relationship between funds for studies of the Nation's highly trained manpower and funds for scientific and technical education is comparable to the relationship between funds for basic research and funds for applied research and development. In the latter case, the Nation has been warned that its basic research effort should not fall below a certain minimum percentage of expenditures for applied research and development, or the Nation's economy and progress may become distorted. Likewise, it seems to NASA that funds for manpower studies should not fall below a certain minimum percentage of funds for support of scientific and technical education. In fact, the base figure for judging the percentage of funds considered desirable for manpower studies should also include the Nation's total expenditures for scientific and technical work, since manpower resources are the most important component and limiting factor in such work.

Considered in these terms, a reasonably high level of support for manpower studies would seem to be well justified, since the Federal Government, industry, and educational institutions spend many billions in educating and utilizing its scientific and technical manpower. Informed policy guidance in the education and utilization of its most precious national resource should prove to be worth much more than its cost.

Agency location for the register and manpower studies

A question has been raised as to what agency of Government should bear responsibility for the program, and whether that responsibility should be exclusive or merely primary.

Alternative organizational locations for the manpower program might include the Office of the President or an appropriate segment thereof, such as the Federal Council for Science and Technology; or the Department of Health, Education, and Welfare if attached direct to the Office of the Secretary; or the National Academy of Sciences-National Research Council.

Other agencies might be appropriate in some respects, but seem to have counterbalancing disadvantages. For example, military connotations which could be deleterious to relationships with the scientific and engineering community, would seem to counter-indicate the Department of Defense, Selective Service System, or OCDM. Skilled-trades connotations would be disadvantageous to the Department of Labor. Commercial and business connotations seem to counter-indicate the Department of Commerce. Other departments and agencies seem to be too specialized in their missions, such as the Department of Agriculture or the Federal Aviation Agency.

Other agencies already have responsibilities for various aspects of the manpower problem, such as the U.S. Public Health Service for the medical sciences, Bureau of Census and bureaus of Department of Labor for various manpower studies, and various defense agencies for mobilization readiness. But these seem to present problems of coordination rather than opportunities for relocation.

All things considered, NASA recommends that the National Science Foundation should retain and operate the register and manpower studies, in the light of its overall agency mission and interests. NASA is also of the opinion that the Foundation should be the sole operator of the register, but should have the primary rather than the sole responsibility for other aspects of manpower fact-gathering and analysis.

Organizational location and status

A question has also been raised concerning the organizational location and status of the manpower program within the Foundation. NASA is in no position to offer any specific recommendations concerning the organizational status the register and manpower studies should have in the Foundation.

NASA notes, however, that the Foundation announced on July 6, 1959, that it is now "accepting leadership in behalf of interested Federal agencies for establishing and maintaining a program of national information on sicentific and technical personnel." NASA feels that this is a good step. NASA also feels that this broadened responsibility for scientific manpower would seem to require a rather high status for the manpower function, since it will involve coordinating the work of other Federal manpower agencies, influencing the work of non-Federal manpower organizations, and also providing policy recommendations to the Foundation, the executive branch, the Congress, and the Nation.

EXECUTIVE OFFICE OF THE PRESIDENT,
OFFICE OF CIVIL AND DEFENSE MOBILIZATION,
Washington, D.C., November 5, 1959.

DR. ALAN T. WATERMAN,
Director, National Science Foundation,
Washington, D.C.

DEAR DR. WATERMAN: This is in response to a request by Mr. Thomas J. Mills, of your staff, by letter of October 5, for an official statement from this agency on certain points raised by the House Committee on Science and Astronautics in its resolution of October 6, 1959.

This request asks, first, for the specific interests, needs, and recommendations of the agency in relation to the register of scientific and technical personnel and scientific manpower studies, as well as projected plans for the future, short- and long-range, in these areas.

We are interested in the register and related scientific and engineering manpower information from two standpoints:

1. Mobilization

We have studied the possible use of the register in both a mobilization under World War II conditions and under a possible nuclear attack. It is our conclusion that it is highly desirable to retain the register for locator purposes since it will have definite value under each of these two situations. The use of the register under World War II conditions is clear. It would be a most important tool for assuring the best utilization of our scientific and engineering talent.

Under nuclear attack, we recognize that the resultant dispersal of people in many areas will make the use of the register more difficult. However, to the extent that any area escapes extreme dislocation of population, the register would still be most useful as a locator.

2. Supply-requirements information on specialized manpower

We are very much concerned that appropriate agencies of Government collect and provide the necessary information for planning purposes needed in the development of national policies and programs to assure (*a*) the maintenance of an adequate specialized manpower mobilization base; and (*b*) that current defense needs for specialized manpower are adequately met. As you know, this office took over, with the assistance of the National Science Foundation, two of the functions of the President's Committee on Scientists and Engineers on its dissolution December 31, 1958. These were the programs on improving the current utilization of scientists and engineers, and the encouragement of community activities designed to achieve a much better training and utilization of high-talent youth, with particular emphasis on the fields of science and engineering. It is our belief that the register and the statistical programs of the Foundation are of assistance in keeping the Nation informed as to the need for action along these two lines.

You have asked for specific comment on four points, which are discussed in order in the following paragraphs:

1. Suggestions as to how the Foundation might secure appropriate information on both the formal training of scientific and technical personnel and their subsequent experience.

Basically, we believe that the Foundation's questionnaire approach has been appropriate for the purposes of the register. Obviously, the more complete the coverage of scientists and engineers, the more valuable the register would be from either the mobilization or the statistical point of view. While we doubt whether the Foundation's voluntary approach toward the register will ever result in complete coverage of either the scientists or engineers, it has appeared to us that there is rather good distribution by discipline and by geographic area under current register operations sufficient to insure that the register would be a most useful device under any mobilization condition. While compulsory registration would have the advantage of completeness, we would not recommend a compulsory registration plan.

On the other hand, there are many measures which we feel could be adopted by the Foundation which would improve coverage under a voluntary system, and we recommend these measures be considered:

(*a*) Prepare a brochure describing the register and its purposes, listing the cooperating societies and any other pertinent information.

(*b*) Use the brochure and other publicity devices so as to make inclusion on the register both a prestige item and a national duty.

(*c*) Request all educational institutions to provide a list of students who receive appropriate degrees each year which would qualify them for inclusion on the register.

(*d*) Request employers to see that their professional and scientific personnel are listed in the register.

(*e*) Provide the registrant with a registration card.

2. The type and kind of information an effective register could most advantageously supply and should be expected to provide.

We are familiar with the manner in which the national register has been operated in the past and believe that the information contained in the current questionnaire would provide the basic information necessary for our purposes in an emergency. We regard the level of information on formal training to be secured as primarily a technical question, best answered by the Foundation itself.

3. In what manner and through what means such a record may best be maintained.

The mobilization value of the register would be enhanced if a set of the register IBM cards would be located at the Department of Labor and OCDM relocation sites, and partial sets at field offices of these agencies, as well as those of the Civil Service Commission. Furthermore, we would recommend consideration be given the programing of current register information on the computer at the OCDM classified site. The more up-to-date the register information, the better its uses for locator purposes in an emergency. We consider the present practice of updating qualifications questionnaires at 2-year intervals to be reasonable for the mobilization functions of the register. Obtaining changes in address at more frequent intervals is desirable, however. A possible means of obtaining such information is the use of a card issued to each registrant certifying his enrollment in the register. Each such registration card would have a tear-off portion for reporting changes of address and/or employer to the register postage free. The register would then prepare and mail a new registration card to the registrant.

4. Any other comment on these or related topics which seems pertinent.

While not directly related to register operations but rather to the Foundation's overall responsibilities for information about scientists and engineers, we urge Foundation support of the following two programs:

(*a*) Periodic estimates of the U.S. scientific and technical manpower supply and requirements situation. We are aware that work is being done toward this aim under NSF sponsorship, particularly the bimonthly Department of Labor report on "Current Labor Market Conditions in Engineering, Scientific, and Technical Occupations." We urge continued support of this activity.

(*b*) Continued work on the Soviet bloc scientific and technical manpower potential in comparison with that of the United States. We would urge support

of those programs which the Foundation has already initiated, with periodic publication of comparative statistics.

Sincerely,

E. L. KEENAN,
Deputy Assistant Director for Manpower.

NATIONAL HEADQUARTERS,
SELECTIVE SERVICE SYSTEM,
Washington, D.C., October 22, 1959.

DIRECTOR,
NATIONAL SCIENCE FOUNDATION,
Washington, D.C.
(Attention: Mr. Thomas J. Mills, Program Director for Scientific Manpower.)

DEAR SIR: Reference is made to your letter of October 5, 1959, wherein you asked for an official statement for use in connection with the preparation of the report on scientific manpower information for the House Committee on Science and Astronautics.

We believe that our national emergency planning requirements have progressed to the stage where the Federal Government should undertake the complete programing and particularly the complete operational responsibility for obtaining and maintaining appropriate information on scientific and technical personnel. This should no longer be done by scientists voluntarily providing this information to their professional societies which, in turn, pass it along to the National Science Foundation. Instead, the required information should be passed directly to the National Science Foundation. The professional scientific societies have performed an admirable service in cooperating with the Foundation in the securing of information. Nevertheless, it is believed that the time has now come when nothing less than a formal, official Government program will suffice. If scientific manpower information is important enough to secure and maintain, then it is important enough to demand that individuals affected be required to cooperate.

There is no doubt, we believe, that prudent emergency planning demands that a current national register be maintained and that the use of this register as a locator device be given considerable emphasis. In time of national emergency we shall need to have up-to-date data on the characteristics, location and availability of skilled, learned individuals. To insure our having such information in time of need, it must be obtained before the need arises.

It is of great importance to individuals themselves that they be listed in this register. It is not at all unreasonable to require that, in consideration for the recognition enrollment extends, they inform the register of all changes in their status, and confirm the currency of their record not less than once each year. In order to distribute the workload involved, each individual could be required to submit his data annually, during the month of the anniversary of his birth.

To the extent that we consider ourselves capable of judging, the type and kind of information presently in the register appears to be adequate, as is the questionnaire presently used to secure this information. We feel, however, that the custodian of the register should provide a system of appraisal and rating to which all enrollees would be subjected.

We believe that the decentralization of the register is of prime importance. The information which it contains will not be of much use unless it is where it can be readily available in the event of an emergency. We are not at all convinced that we will ever know enough about any postattack situation to ever assume that certain localities will remain untouched and functioning or that communications will be undamaged or quickly restored. The greatest possible decentralization is the greatest possible insurance that we will have the information when we need it. Consideration should be given to breaking down the register into State lists and these lists lodged with State Directors of Selective Service for preservation and use.

Finally, in the event the National Science Foundation does not feel that it should maintain and service the national register, we suggest that most serious consideration be given to the assignment to the Selective Service System of the responsibility for the register.

For the Director:

JOEL D. GRIFFING,
Colonel, Infantry, Chief Planning Officer.

THE SECRETARY OF HEALTH, EDUCATION, AND WELFARE,

Washington, December 14, 1959.

Dr. ALAN T. WATERMAN,
Director, National Science Foundation, Washington, D.C.

DEAR DR. WATERMAN: This is in response to the Foundation's request that this Department set forth some of its specific interests, needs, and recommendations in the scientific manpower field to assist in the preparation of a report by the Foundation to the House Committee on Science and Astronautics.

We have prepared a statement, which is attached, which I hope may be of some use to you and your staff in the preparation of the report to the House committee.

Sincerely yours,

ARTHUR S. FLEMMING,
Secretary.

SCIENTIFIC MANPOWER—HEALTH, EDUCATION, AND WELFARE

The resolution of the House Committee on Science and Astronautics requests the National Science Foundation to submit a comprehensive report covering: "(*a*) the status of the Scientific and Technical Manpower Register and the scientific manpower studies, and (*b*) the projected plans for the future, short range and long range, in these areas."

The committee instructed the National Science Foundation to "consult with other interested agencies of Government including * * * the Department of Health, Education, and Welfare * * * and include in its report summaries of the specific interests, needs, and recommendations of such agencies."

The committee has also directed the Foundation to recommend "What agency of Government should bear responsibility for the program, and whether that responsibility should be exclusive or merely primary."

This Department has no present recommendation as to what the organizational setting should be for management of the kind of manpower program hereinafter described. Our greater concern is that there be a broad and comprehensive program which would encompass the various phases of manpower planning which we feel are important.

The interests of the Department of Health, Education, and Welfare in scientific manpower and education are broad and far ranging. They include the reponsibility for leadership in education inherent in the Department and the Office of Education; the administration of fellowship and training programs, administered by the Office of Education, the Public Health Service (primarily the National Institutes of Health), and the Office of Vocational Rehabilitation; and appraisal of the resources, requirements, and utilization of scientific manpower currently involved or required to meet future needs in respect to the programs with which the Department is concerned.

Thus, since most of the programs of this Department require the skilled services of people trained in medicine, various social sciences, education, and related disciplines, we have concern that there will continue to be an adequate supply of trained manpower to meet the needs in these fields, not only at the National, State, and local levels of the public service, but also in the universities, foundations, and research organizations which have professional concern with the same types of human problems with which our Department deals.

We are all aware of the important needs for trained personnel in the physical and natural sciences which emerged so dramatically during World War II and in connection with the postwar defense research programs. Emphasis has been given to increased training in these sciences in the schools and colleges of America, both in quantity and quality. These efforts are certainly important and necessary if we are to maintain the level and quality of scientific research and development needed for national security. However, all of these programs designed to increase the manpower pool in the physical and natural sciences should be developed in a manner consistent with a balanced distribution of trained skills in the total population. The complex political world in which we live requires that this country have its full share of trained specialists in the humanities, the arts, the social sciences, and related disciplines to the end that the Nation can exercise leadership and skill in developing international understanding and methods through which the peoples of the world can find ways to live together in peace.

While it may not be possible to define objectively what an optimum distribution of trained skills among the many specialized fields should be, those responsible for long-range manpower planning must be alert to the potential danger of distortion

of our national cultural pattern through efforts to meet immediate and seemingly more pressing demands for one kind of special skill over another. It could well be that the ultimate preservation of our civilization as we know it will depend as much upon our trained citizens in such fields as law, anthropology, ethnology, sociology, and political science, as it will upon those concerned with immediate defense problems. In this connection, there is attached a communication of this Department to the President's Adviser on Science and Technology with respect to research priorities. You will find in that statement a fuller indication of the point of view expressed above.

It is hoped that the National Science Foundation will consider this point of view as it assesses its manpower responsibilities and either include the social sciences and the humanities in its registration and supply and demand studies and programs, or arrange for them to be considered under Federal sponsorship [1] through such organizations as the councils of professional and learned societies or the large foundations.

At some point in the planning process, there should be overall responsibility in Government for equating, one against the other, the various potential claims on manpower which emerge in connection with projected research and educational programs. It is generally true that there is a tendency for particular scientific groups to be zealous in the projection of needs in their own fields. Thus, if representatives of some specialized fields, and this is generally true in such areas as the law, philosophy, and other social sciences, are not present at the planning table, the national needs for highly trained specialists in such fields tend to get less consideration than they should be given, or lost sight of altogether.

Before commenting on points 1, 2, and 3, stated in Mr. Mills' letter of October 5 to Mr. O'Brien, may we set forth our more general interests, needs, and requirements.

Graduate education

First of all, we urgently need better information on graduate education. An excellent beginning has been made here with a study of graduate enrollment by field of science, jointly sponsored by the National Science Foundation and the National Institutes of Health and conducted by the Office of Education. This is the first in a regular series which next year will be expanded to include other fields in addition to the sciences and the health professions.[2]

Coverage

The Department and its constituent agencies need reliable, timely information that will materially improve our knowledge and understanding of the dynamics of the scientific manpower pool. At the present time, however, many of the Foundation's surveys and the register exclude medical practitioners, social scientists, and health professions from "scientific and technical personnel." Unless the definition of scientific manpower is broadened, the data produced by the Foundation will not be sufficiently comprehensive to meet our needs and those of other major Federal agencies and non-Federal bodies concerned with the life sciences and the social sciences.

The Department faces important policy problems that cannot be resolved adequately without more comprehensive and precise data on medical practitioners and social scientists engaged in research. Most physicians combine research with teaching and/or service in medical schools, hospitals, Government agencies, research institutions, and community health agencies. It is vitally important that this group, which forms the backbone of the research effort in medical schools, be considered as scientific personnel. The same is equally true for manpower in the social sciences and the health professions, especially those engaged in research. Federal agencies and other organizations concerned with scientific manpower resources and requirements must view these resources and requirements in their totality. It is, therefore, recommended that the National Science Foundation, in consultation with this Department and other interested agencies, specifically provide for full coverage in its surveys and in the register of professionally trained personnel in the medical, health, and social science fields, engaged in research and/or teaching.

[1] Possibly the Office of Education.

[2] The 60 major educational subjects covered include mathematics, biological and physical sciences, agriculture, the health professions and selected social sciences closely connected with medical research. Next year the study will be expanded to include other fields in addition to the sciences and health professions, will provide 3 years' advance notice of the probable numbers of graduates in given subjects, and provide data on possible shortages of graduate students in given subjects.

Future needs

The Department is constantly seeking better information on manpower needs, demand, and supply. It is recognized that the concept of needs is less precise than the manpower economist's interpretation of demand. Nevertheless, an overall assessment of future manpower needs is essential to provide a firmer foundation for policy and program decisions. Recent efforts to project the expected growth and probable character of medical research as a basis for policy planning have thrown into a sharp relief the value of a broader, long-range framework for scientific manpower information within which a more specific need for science Ph. D.'s, M.D.'s, and social scientists for medical research can be appraised.

Accordingly, it is recommended that studies be undertaken to appraise overall scientific manpower needs, taking into account the changing structure of our society and economy, emergent technological developments implicit in the advances of nuclear fission, electronics, medical research, and space exploration; the impact of further urbanization, the readily predictable, significant shifts in population distribution, and the need for scientific manpower to carry out the mounting international obligations of the United States. Data which shed some light, however dimly, on the future are more valuable for policy planning than those which merely illuminate the past and present.

Long-term demand

The Department also recommends additional, more sophisticated studies of long-term demand for scientists and supporting personnel. As it takes from 7 to 10 years of postsecondary schools training to produce a qualified scientist, as accurate an assessment as possible of our needs for 10 years hence is most urgently needed. To be of value, such an assessment cannot be made in gross terms but must attempt to delineate requirements in specific disciplines. The results of such a study will inevitably be more in the nature of guesses than estimates, but such guesses may well provide better policy guidance than historical projections or the extrapolation of current employment patterns.

It is in this kind of long-term projection that attention can be given to the trends of specialized training which might tend, over the long run, to bring about imbalances within the scientific manpower pool itself. If these trends are significant, the Foundation would be in a position either to take the responsibility itself or to secure the judgment of others in ascertaining whether national efforts to stimulate training in one field or another are being accomplished in the light of total national needs, as defined in terms which cover the whole spectrum of needed skills in the population.

Suggestions as to how the Foundation might secure appropriate information (question No. 1)

In offering suggestions as to how the Foundation might secure appropriate information on the training and experience of scientific manpower, the central questions are: Why is this information desired? What will it be used for?

Information of this character has been collected through the operation of the National Register of Scientific and Technical Personnel. However, both the report of the House committee and the report of the review panel chaired by Dr. Dael Wolfle indicate there does not seem to be complete agreement within the Science Foundation on these questions. It is assumed that these questions will be dealt with fully in your draft report.

Thus far, the register has been looked upon as a mobilization resource, a means of obtaining salary and income data of interest to members of the professional societies, and a finders list. It is the view of the Department of Health, Education, and Welfare that the register, if it is to be continued in operation, should serve as a central source of sorely needed, up-to-date information on the characteristics of the Nation's scientists primarily focused upon the Ph. D. or equivalent trained group. To realize this potential, it would be necessary to extend the coverage, to refine both the information sought and its analysis in the light of program requirements of the principal users; and especially to shorten processing time which is now inordinately long.

The information might be obtained from the professional societies as it is now being done. An alternative would be complete coverage of the Ph. D. or comparable professional level because this is the most critical group in terms of limited numbers, high degree of specialization, long period of training, and research, which is becoming an increasingly vital factor in our Nation's welfare. Again, we believe that Ph. D. level social scientists should not be excluded. Conceivably, information on technical personnel can be obtained through sample methods or through

some expansion of the establishment-type surveys. The varied and sometimes ill-defined outer limits of the engineering profession make this field particularly difficult to deal with in register terms. It might be sufficient to cover this broad field in terms of finders lists or other similar techniques to be worked out with the organized engineering societies or the Engineers' Joint Council. This might also be an adequate method in the field of chemistry, where so many members of the field become journeymen practitioners at the bachelor's or master's level. In developing these techniques, of course, the register should not regard the possession of an advanced degree as the only and controlling element of scientific qualification. Achievement, awards, and honors, education below the Ph. D. level, and other criteria should enter into the determination as to whether individual scientists should be considered for registration.

The type and kind of information (question No. 2).

In addition to the type of information already sought on the register, it is the Department's view that as new variables or characteristics take on policy significance, they should be added to the register questionnaire. For example, the register data should show whether the scientist received support during predoctoral and postdoctoral training and, if so, the sources of such support. Additional information of a similar character is needed with respect to research activity. The information would indicate the nature of the research and the sources of support. Information is currently obtained on the amount of the scientist's income; data on source of income will become increasingly important.

In what manner and through what means such a record may best be maintained (question No. 3).

This is a matter of administrative and technical judgment for the Science Foundation. However, if the information is to be utilized promptly with minimum delay after collection and with maximum flexibility in analysis, it would be well to take advantage of the most advanced technology available for storage and retrieval of information. At the minimum, the operation should be geared to tape and not limited to punchcards as in the present case.

The report of the Science and Astronautics Committee implies that the register operation has not been adequately supported financially and has been placed at too low an echelon in the organizational structure of the Foundation. To assume certain of the responsibilities we are recommending, it would, of course, be necessary to expand the register operation in terms of increased financial and administrative support. However, we do not feel that we are in a position to make specific recommendations as to the internal organization of the Foundation with respect to the register. There will be complete agreement on the fact that the ultimate strength of American science in all areas rests in the skills of its highly trained citizens, and the need to have knowledge of our national manpower resources and to project national manpower requirements represents a problem which must be dealt with at high organizational levels.

Research Priorities of the Department of Health, Education, and Welfare

The Department of Health, Education, and Welfare has three principal missions: (1) Promotion of economic security and social welfare; (2) promotion of the public health and safety; and (3) promotion of education. These missions are carried out by the principal operating agencies of the Department: the Social Security Administration, the Public Health Service, the Office of Education, the Office of Vocational Rehabilitation, and the Food and Drug Administration. Each of these agencies has substantial research needs, primarily in the life and social sciences. Furthermore, the broad research interests of the Department are closely interrelated.

In order to be realistic in the establishment of priorities for research, the great likelihood must be recognized that the Nation currently is in the early stages of an era which will witness a tremendous intensification and broadening of our total research effort. One of the cornerstones of this effort will of necessity be research into the life and social sciences which are the fundamental research interests of this Department.

Research priorities in fulfilling departmental missions

A discussion of research priorities of the Department will be most meaningful if it is recognized that, while there must be an orderly expansion of our medical research program, it may be more urgent to begin a modest program for socio-economic research. For example, the 1960 appropriation for public assistance is $2.03 billion, which represents about two-thirds of the total appropriations to this Department. Yet, Congress has repeatedly denied requests for very small amounts for research relating to the causes and prevention of dependency and similar problems. Conversely, the relatively small sums spent during the past few years on research in the field of rehabilitation are already producing economic dividends.

In terms of research priority needs with respect to the Department's mission, the biomedical research area is the field to which greatest priority is attached in terms of basic support. Because of large increases in appropriations in recent years, this area is relatively much better financed at present than the needs for educational, socioeconomic and similar types of research. From the standpoint of urgency for immediate additional funds in the research field, therefore, the priorities would be reversed.

With respect to the present unmet research needs of the Department, therefore, high priority should be given to each of the following:

Initiation of socioeconomic research, including the field of health economics, the health, education, and welfare implications of extremely rapid population growth, the relationship of juvenile delinquency to physical, psychological, and socioeconomic factors, and the causes and cures of economic dependency.

Expansion of educational research, including research in the learning process, differential methods of teaching students of widely differing capacities and interests, methods for improving the organization, operation, and financing of educational institutions, districts and other bodies, and other research ranging from basic and theoretical to highly problem-oriented research.

Strengthening of research relating to environmental health problems, including expansion of research in occupational health; foods, drugs, and cosmetics technology; sanitary engineering (including the development of new and improved methods of water and waste treatment); radiation health; air pollution; and accident prevention.

Strengthening of research in the behavioral sciences. Improvements in transportation and communication, along with the rapid growth of population, will result in aggravation of a variety of tensions, which can only be met by the development of much more precise knowledge on the behavior of individuals and groups in society.

Development of urgently needed techniques for effective dissemination and prompt application of knowledge gained from basic research, thereby reducing the timelag between acquisition of knowledge and obtaining the benefits from its application. For example, needless deaths and disability from poliomyelitis, infectious diseases, and certain forms of cancer and cardiovascular disease could be prevented by effective application of basic research findings. Similarly, the prevention and control of juvenile delinquency might be considerably advanced if research findings in the social sciences were adequately developed for prompt application.

In each of these areas it will be necessary to develop a well-trained corps of scientific manpower. Significant expansion of research in environmental health and in the field of education will require additional laboratory facilities and equipment.

National priorities for research

There is every reason to believe that there will be very rapid intensification and broadening of the Nation's research effort. To mount such a broadened effort will require a substantially enlarged supply of well-trained investigators and modern, well-equipped facilities. Thus, to meet the Nation's future needs, the very highest priority should be given now to measures designed to (1) seek out potential research personnel, (2) provide for their education, and (3) make careers in research (especially in academic institutions) attractive.

Many of the most significant advances in the physical and life sciences have come from research in such fields as mathematics, chemistry, and physics. It is imperative that any rapid expansion of the total national research effort include a proportionate increase in support of the basic sciences. Thus, this Department places a very high priority on efforts to increase research in the basic sciences (i.e., nondirected research of a fundamental nature).

Finally, there is great need for initiating major efforts to understand better how human values are developed, and how they affect the formulation of high public policy on major issues of Government. The development of knowledge necessary for wise public policy formulation is dependent on research not only in the physical and life sciences as such, but also in subjects such as philosophy, history, political science, and sociology, which must rest upon their own independent sources of inspiration, apart from natural science. Thus, from the standpoint of the Nation's broad research mission, this Department would place a high priority on the strengthening of our efforts in the social sciences.

Although the Federal Council for Science and Technology is primarily concerned with research in the physical and biological sciences, it should also be of concern to the Council that the major problem areas of our society which may determine the continuity of our civilization involve difficult relationships between individuals, groups, and nations which deserve intensive study worthy of the term research. Much careful thought needs to be given to the steps which would form a plan of action to assure that many of the best and wisest minds of our society are freed from the pressures of other types of activity to explore ways of reducing interpersonal, intergroup, and international tensions. Extremely limited amounts of the time of the most talented and mature minds of our society are devoted to basic or long-range studies of such vital subjects. No area is in greater need of increased effort and attention.

NOVEMBER 5, 1959.

CENTRAL INTELLIGENCE AGENCY,
Washington, D.C., December 29, 1959.

Dr. ALAN T. WATERMAN,
Director, National Science Foundation,
Washington, D.C.
(Attention: Mr. Thomas J. Mills, Program Director for Scientific Manpower.)

DEAR ALAN: Reference is made to your letter of October 5, 1959, requesting comments on four questions which have been raised in connection with the preparation of a report or the Committee on Science and Astronautics of the House of Representatives. Before attempting to comment briefly on these questions, we believe that it is important to indicate our general support for the continuation of the National Register of Scientific and Technical Personnel, perhaps in an expanded form, under the general supervision of the National Science Foundation.

The Foundation's scientific manpower program, as it is now operated, appears to be divisible into two components: (*a*) the register, which currently maintains records on 170,000 individual scientists of Ph. D. level or equivalent in the natural sciences, and the finder's list of 20,000 key engineers, and (*b*) study programs for the investigation of certain scientific manpower problems.

The present register is maintained through the cooperation of a number of national scientific societies, and is therefore on a voluntary-response basis and is necessarily incomplete (from the standpoint of 100 percent registration of the Nation's scientists and engineers). There seems to be general agreement that the register, based on this type of support, should not be used by any governmental or private agency as a recruiting device, except in a national emergency. With this understanding, we have attempted to comment on the four questions asked, primarily from the needs of this Agency:

1. *Suggestions as to how the Foundation might secure appropriate information on both the formal training of scientific and technical personnel and their subsequent experience*

The problem of supplying information of this type can be approached from two general directions, i.e., by soliciting information from the individual scientists and by contacting employers, educational institutions, etc. With regard to the Foundation's study program, both approaches are potential sources of useful information. However, inasmuch as the study program involves certain projects in which attitudes, beliefs, effect of environmental conditions, etc., are very important, it appears that the Foundation cannot rely entirely on a questionnaire-machine-run type of program. Considerable attention should be given to the personal interview approach in an effort to obtain that type of information in which the various shades of meaning are important.

With regard to the register, a machine-run questionnaire approach, as practiced at present, seems more useful. However, we believe that before the above question can be answered completely, an analysis must be made concerning the ultimate

purposes for which the register is maintained. In turn, the results of this analysis should then permit a determination of the need or lack of need for achieving a more complete coverage of the Nation's scientists and engineers than is currently attained. It seems apparent that reliance on a voluntary response from individual members of the various societies, as is now practiced, can never approach 100 percent coverage (many are not members: all members will not respond). Therefore, the need for 100 percent coverage, if it can be supported, forces a consideration of alternative methods of approach. One of these alternative methods, to which serious consideration should be given, is that of compulsory registration of engineers and scientists. Some estimate should also be made of the increase in cost that such a method would entail as compared to the present system.

2. The type and kind of information an effective register could most advantageously supply and should be expected to provide

The purposes for which this Agency employs information such as might result from a register and its accompanying study programs require that the data constitute a complete inventory of all persons of B.A. to B. Sc. level and above, with information by field, for fields of agriculture; the biological sciences; engineering; forestry; geography; the health professions; mathematical subjects; military, naval, and Air Force science; the physical sciences, and psychology (these classifications are taken from publications of the U.S. Office of Education).

This inventory should distinguish the number in each field who are available (i.e., who have graduated from a given curriculum) at the various levels of qualification and the number who are employed in the various activities which utilize these personnel, i.e., activities such as production, design, testing, research, development, management, education, distribution and procurement, operation, maintenance, clinical practice, etc., in the various branches of industry and other areas of the national economy.

This Agency's needs include not only current inventories, but also annual projections over a 10-year period, and parallel data and projections on graduations, awards of advanced degrees, and employment trends.

3. In what manner and through what means such a record may best be maintained

The answer to this question appears again, in part, to rest on a more complete study of the ultimate purposes of the register. Assuming that a need for 100 percent coverage exists, it is quite possible that an appropriate machine-based system should be housed, staffed, and operated by NSF itself, rather than have NSF rely on a university-based system as at present. In any case we believe this approach should be considered and that it should not be ignored completely in the report to the House committee.

4. Any other comment on these or related topics which seems pertinent to you

We have no other general comments. Certain of our problems have already been discussed with representatives of the National Science Foundation. We are pleased to be able to participate in the preparation of the report for the House Committee on Science and Astronautics.

Sincerely,

HERBERT SCOVILLE, JR.
Assistant Director.

Appendix B

Listing of National Science Foundation Publications on Scientific Manpower

SCIENTIFIC MANPOWER BULLETINS

10. "Scientists and Engineers in American Industry—January 1957, A Preliminary Report," December 1958.
9. "Foreign Language Knowledge of American Scientists—1954–55," October 1958.
8. "Immigration of Professional Workers to the United States—1953–56," February 1958.
7. "Employment Profile of Scientists in the National Register of Scientific and Technical Personnel—1954–55," November 1956.
6. "Shortages of Scientists and Engineers in Industrial Research," August 1955.
5. "Highlights of a Survey of Graduate Student Enrollments, Fellowships, and Assistantships—1954," July 1955.
4. "Manpower Resources in Meteorology—1951," August 1954.
3. "Manpower Resources in the Geophysical Sciences," July 1954.
2. "Highlights of a Survey of June 1951 College Graduates," March 1954.
1. "Manpower Resources in Mathematics—1951," December 1953.

PROCEEDINGS OF SCIENTIFIC MANPOWER CONFERENCES HELD IN CONJUNCTION WITH THE ANNUAL MEETINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

"Scientific Manpower—1958," Papers of the Seventh Conference on Scientific Manpower and the Symposium on Demographic and Sociological Aspects of Scientific Manpower.

"Scientific Manpower—1957," Papers of the Sixth Conference on Scientific Manpower.

"Scientific Manpower—1956—Significant Developments, Views and Statistics" (Fifth Conference).

"Papers of the Fourth Conference on Scientific Manpower" (1954).

"Papers of the Third Conference on Scientific Manpower" (1953).

"Proceedings of the Second Conference on Scientific Manpower" (1952).

"Proceedings of the Conference on Scientific Manpower" (1951, First Conference). Published by the Office of Naval Research, Department of the Navy.

SCIENTIFIC MANPOWER AND EDUCATION REPORTS

"Brief Summary of Data on the Training of Scientists and Engineers in the United States" (For the Organization for European Economic Cooperation Annual Review—1959), 1959.

"American Science Manpower—Employment and Other Characteristics, 1954–55," 1959.

"National Science Foundation Programs for Education in the Sciences," 1959

"A Program for National Information on Scientific and Technical Personnel," 1958.

"Scientific Manpower in the Federal Government—1954," 1957.

"Graduate Student Enrollment and Support in American Universities and Colleges—1954," 1957.

"Engineering and Scientific Education—Foundation of National Strength," Background Data for Conference on Higher Education, Science and Technology, October 31–November 2, 1957.

"Federal Support for Science Students in Higher Education—1954," 1956.

"Trends in the Employment and Training of Scientists and Engineers," 1956.

"Scientific Personnel Resources, A Summary of Data on Supply, Utilization and Training of Scientists and Engineers," 1955.

"Education and Employment Specialization in 1952 of June 1951 College Graduates," 1955.

"Soviet Professional Manpower—Its Education, Training and Supply," by Nicholas DeWitt, 1955.

"Manpower Resources in the Biological Sciences," 1955.

"Manpower Resources in the Earth Sciences," 1954.

"Manpower Resources in Mathematics," 1954.

OTHER SELECTED NATIONAL SCIENCE FOUNDATION REPORTS

"Science and Engineering in American Industry—Report on a 1956 Survey" (In press, to be released early in 1960).
"Scientific Research and Development in Colleges and Universities, Expenditures and Manpower—1953–54," 1959.
"Scientific Activities in Six State Governments—Summary Report on a Survey, Fiscal Year 1954," 1958.
"Research Expenditures of Foundations and Other Nonprofit Institutions—1953–54," 1958.
"Scientists and Engineers in Research and Development—1954," Reviews of Data on Research and Development, No. 9, February 1958.
"Science and Engineering in American Industry—Final Report on a 1953–54 Survey," 1956.
"Research and Development by Nonprofit Research Institutes and Commercial Laboratories—1953," 1956.
"Research by Cooperative Organizations—A Survey of Scientific Research by Trade Associations, Professional and Technical Societies, and Other Cooperative Groups, 1953," 1956.
"Scientific Research Expenditures by the Larger Private Foundations," 1956.

PUBLICATIONS RESULTING FROM NATIONAL SCIENCE FOUNDATION SUPPORT

"Current Labor Market Conditions for Engineering, Scientific, and Technical Personnel," Bureau of Employment Security, U.S. Department of Labor. (Current bimonthly series of reports.)
"Sanitary Engineering Manpower," Public Health Service, U.S. Department of Health, Education, and Welfare, 1959.
"Availability of Retired Military Officers to Teach Mathematics and Science," Public Management Research Institute, Washington, D.C., 1958.
"Scientific Careers and Vocational Development Theory," by Donald E. Super and Paul B. Bachrach, Teachers College, Columbia University, New York, N.Y., 1957.
Report of the Exploratory Survey of Availability of University Women for Teaching in the Fields of Sciences and Mathematics, American Association of University Women, Washington, D.C., 1957.
"Engineering and Scientific Education, Foundation of National Strength, Conference Proceedings, October 31–November 2, 1957," 1957.
"The Demand and Supply of Scientific Personnel," by David M. Blank and George J. Stigler, National Bureau of Economic Research, New York, N.Y., 1957.
"Background Factors Relating to College Plans and College Enrollment Among Public High School Students," Educational Testing Service, Princeton, N.J., April 1957.
"Background Factors and College-Going Plans Among High-Aptitude Public High School Seniors," by Glen Stice, William G. Mollenkopf, and Warren S. Torgerson, Educational Testing Service, Princeton, N.J., August 1956.
"The Science Doctorates of 1957 and 1958, Their Numbers, Backgrounds, and Employment," by Lindsey R. Harmon, National Academy of Sciences-National Research Council, Washington, D.C., 1959.
"Doctorate Production in United States Universities, 1936–56, With Baccalaureate Origins of Doctorates in Sciences, Arts, and Humanities," National Academy of Sciences-National Research Council, 1958.
"Baccalaureate Origins of Science Doctorates Awarded in the United States, 1936–50," National Academy of Sciences-National Research Council, 1955.
"Research Conference on the Identification of Creative Scientific Talent," Proceedings 1959, University of Utah, Salt Lake City, Utah. (In press.)
"Research Conference on the Identification of Creative Scientific Talent," proceedings 1957, University of Utah, 1958.
"Research Conference on the Identification of Creative Scientific Talent," proceedings 1955, University of Utah, 1956.
"Engineering Education Exchange Mission to Soviet Union, November 1958, Final Report," American Society for Engineering Education, University of Illinois, Urbana, Ill. (Contained in Journal of Engineering Education, May 1959, vol. 49, No. 9.)
"Engineering Enrollment and Faculty Requirements, 1957–67," American Society for Engineering Education, University of Illinois, 1958.

"Salaries and Earnings of Engineering Teachers, 1956," American Society for Engineering Education, University of Illinois, 1957.
"Salaries and Income of Engineering Teachers, 1958," prepared for Engineers Joint Council and American Society for Engineering Education, Engineers Joint Council, New York, 1959.
"Demand for Engineers—1957," Engineers Joint Council, New York, November 1957.
"Classifications for Surveys of Highly Trained Personnel," by J. F. Wellemeyer et al., American Council of Learned Societies, Washington, D.C., 1953 (in cooperation with the then National Scientific Register).
"Manpower Resources in Chemistry and Chemical Engineering," Bureau of Labor Statistics, U.S. Department of Labor, 1953 (in cooperation with the then National Scientific Register).
"The Composition of the Sanitary Engineering Profession," U.S. Office of Education, 1952 (published by the National Scientific Register).
"Manpower Resources in Physics—1951," U.S. Office of Education, 1951 (published by the National Scientific Register).
"Research and Development Personnel in Industrial Laboratories," U.S. Office of Education, 1950 (published by the National Scientific Register).

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